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# THE RELATION OF ENGINEERING TO INDUSTRIAL MANAGEMENT

By D. S. KIMBALL, ITHACA, N. Y.

WE have all become somewhat accustomed to seeing the engineer called upon to perform new and strange duties, but few of us were prepared, I believe, to see an engineer called upon to undertake the greatest piece of constructive economics ever attempted. I refer to the work of Mr. Hoover, for Mr. Hoover is by training and practical experience a mining engineer. Yet this somewhat startling event is in full keeping with the trend of modern industry. Every day sees the duties and responsibilities of the engineer widened and it is difficult to see where the end will be. The engineer from the first has had a difficult time trying to define just what his field of activity is. This is necessarily so in any civilized community where the life of the people rests upon mechanical contrivances. Engineering, and mechanical engineering in particular, is an integral part of everyday life and necessarily assumes fresh aspects as the complexity of modern life increases. It will be increasingly difficult to set its limits and boundaries.

*In the preceding issue of The Journal was given a complete though necessarily somewhat condensed account of the Thirty-eighth Annual Meeting of The American Society of Mechanical Engineers. So much space was needed, however, to recount what have been referred to as the "war features" of this convention, that last month no more than a passing review of the usual technical proceedings of the meeting could be given. This issue contains an extended account of these proceedings, with discussions, oral and written, of the engineering papers presented. The issue therefore really constitutes a supplement to the preceding number.*

*Prefacing this discussion is an address by Prof. D. S. Kimball, member of the Society's Committee on Meetings, which is particularly timely in view of the tendency of the Society to interest itself in matters of "social economy," a course which is justified in the mind of every member at this critical period in the history of democracy.*

These matters have long been a cause for work and worry on the part of teachers in technical schools. The original conception of these institutions was to train men to design, build and operate machines within a narrowly defined field. Fifty years ago the term "mechanical engineer" conveyed a fairly distinct definition of activity; today it is almost meaningless.

The closely prescribed curriculum of the early engineering schools of years ago succeeded well in sending out men who in time made a place for themselves in the engineering field. But the men who passed through these schools were far from satisfied with the training they thus received. Their complaint, however, has not concerned the technical studies imposed upon them alone, but has embodied a demand for broader training in harmony with changing industrial conditions. The variety and scope of these demands have been great and have changed with the changing industrial field, but the demand for instruction in the subjects that pertain to industrial management has been constant, insistent and has grown steadily. Today there is not a first-class technical school in this country that is not recognizing this demand. The technical schools of today are not places where engineers, as defined by this term originally, are educated, but they are schools that prepare men, and women also, for industrial life in an amazingly broad manner. An examination of the list of graduates of any good technical school will show that twenty-five per cent of them remain in engineering pursuits in a narrow sense, the remainder going into a very wide variety of industrial pursuits. A very large and increasing proportion are found on the management side of industry.

It may be argued, of course, that while engineering may be a part of management, management is not part of engineering. And it may be truthfully stated that the engineer has been drawn over into management more because of his peculiar method of attacking problems than because of his technical or commercial knowledge; and that for this reason engineering colleges may well neglect these broader subjects and confine themselves to the time-honored engineering studies. While this may all be true theoretically, the fact remains that the industrial field is demanding men from the engineering schools who are well grounded in engineering and, in addition, know something of management. Hence we find such subjects as economics, psychology, logic, public speaking, and similar studies included in engineering curricula, and they appear no more or no less strange there than does an engineer as a food administrator.

Now what is true of the engineering schools is equally true of The American Society of Mechanical Engineers. The engineering colleges have lagged behind the industrial field in these matters, and the engineering societies in turn have lagged behind the colleges. It is interesting and instructive to read what the founders had in mind when the Society was organized in 1880. Dr. Robert H. Thurston, the first President, in his inaugural address states these objects to be "the promotion of the arts and sciences connected with engineering and mechanical construction." And the chairman of the preliminary meeting, Mr. A. L. Holley, enumerates in some detail the several branches of engineering contemplated as follows: metallurgy, railway engineering, machine-shop work, rolling mills, structural work, national defenses, shipbuilding, agricultural machinery and textile machinery, and concerning the latter he states, "The public would deem it quite outside of mechanical engineering." It is on this analysis as a basis that the first list of those eligible to election was made up, namely, mechanical engineers, civil engineers, military engineers, mining and metallurgical engineers and architects. And after reviewing the field, which to us now seems so restricted, Mr. Holley remarks, "I confess that in thinking over the range of mechanical engineering with reference to our proposed society I was astonished at its magnitude. I had never realized it before."

Only once in the statements made by the founders concern-

Presented at the Luncheon, on Thursday, December 6, 1917, at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

ing the objects of the Society do we see a vision of what the future held for the Society when Dr. Thurston said, "Its province will lie no less in the field of social economy than in that which has reference only to the individual needs of its members." This germ of thought has always remained in the Society and found its most widely known expression in Frederick W. Taylor's classic paper on Shop Management. But though this remarkable paper was presented to the world through the Society, comparatively little has been done by the Society to further this important line of thought. There is not even at this time a sub-committee on this field of work.

Ten years ago Prof. F. R. Hutton in his presidential address made an exhaustive review of the aims and activities of the Society which is well worth reading. He found that about fifty per cent of the membership at that time was classifiable under the headings "manufacturer," "shop executive" and "local manager." Yet the TRANSACTIONS for that year do not contain a single paper on industrial administration, though Taylor's masterpiece had been published three years before. An examination of any page of the year book will show that this relation has not changed and that the Society is far from being, strictly speaking, an engineering society, but that it represents industry in a very comprehensive and broad manner. That this view is recognized is clearly shown by the names of a few papers in the TRANSACTIONS for 1916, as for instance, How Does Industrial Valuation Differ from Public Utilities Valuation, or Graphical Control on the Exception Principle for the Executive.

What is true of the relation of mechanical engineering to management is also true of many other fields. Is the problem of electric welding one for the mechanical engineer or does it belong to the field of electrical engineering? Where shall we place oxy-acetylene welding or the thermit process? Accident prevention is certainly within the range of the Society's activity, so far as the mechanical features are concerned, but how far shall we interest ourselves in employers' compensation acts and the legislation that lies back of this important movement? Shall we discuss it as a problem in mechanical engineering or shall we also include the humane features of the problem? At the present moment a strong movement is on foot to interest engineers in the important problem of Americanization, and engineering schools are being urged to pay special attention to this matter. The subject is timely and important and no single class of men can do so much to promote it as the engineers. The problem is closely connected with industrial management; shall it become, therefore, a problem for engineers and engineering societies?

These intricate relations come before the Society largely through the work of the Committee on Meetings in passing upon papers to be presented before the Society. As would be expected from the foregoing, the papers offered cover a very wide range. The majority are well within the range of the field of engineering as commonly understood, a number are in the field of industrial management or in other fields equally removed from engineering in a strict sense. From this latter class the Committee on Meetings selects those that, in its opinion, can properly be presented, though even with this class of paper the Committee is not always unanimously agreed. Lastly, there are a number of papers presented that in the opinion of the Committee are so far removed from engineering as to make their presentation questionable, though they are sometimes valuable papers. The tendency, therefore, is rather to discourage papers which treat of matters on the "fringe" of engineering. I sometimes wonder if Taylor's paper on Shop Management, had it been presented by some one less known and under some other title, would have been accepted. It is fairly certain, moreover, that if more encouragement were given to papers of this broader character the Meetings Committee would be in receipt of many more of them, and it is not too much to expect that it would, in time, receive papers that would be as great in their field as is Taylor's classic. It is entirely a matter of how far the Society wishes to recognize its non-technical membership. It is noteworthy that the best collection of papers on the problem of employment of which I am aware is not found in the literature of engineering or industrial management, but is in the Annals of the American Academy of Political Science. I wonder how many employers have seen them. Quite a number of these papers were written by engineers and industrial executives. It is also to be noted that within the last year at least two societies have been started to carry out work that, in my opinion, belongs to this Society.

I believe the time has come, therefore, when the Society should redefine its aims and objects, and I would like to see an inquiry made into the aims and objects of our Society with a view to finding out how well the literature of the Society is meeting the wants of our membership. Or, putting it another way, if we are satisfied with the literature I think we should try to obtain a membership that is in harmony with it, a condition which, in my opinion, does not exist at present. And I should like to see such an inquiry made in a statesmanlike manner without reference to persons or groups of persons, but with the sole object of finding out what is best for the Society and what will insure to it an enduring future.

There will never be a better or more opportune time to consider this subject. Every loyal American is now asking himself what are his duties and responsibilities. Every technical school is facing a reorientation of its purposes and aims. As a nation we are facing a period of self-analysis that may result in changing some of our fundamental policies. I am not so sure, for instance, that we shall continue to be a "refuge for the oppressed of the earth" unless we are quite sure that the aforesaid oppressed are really in pursuit of the liberty and happiness that we all hold so dear. Americanization may indeed be a part of the work of all organized bodies that are interested in the existence of the Republic. If we have not at this moment a clear vision of whither we are tending, now is the time of all times to take stock of ourselves and to redirect our course, whether this course is in conformity with time honored definitions or not. Change is not necessarily synonymous with progress, but there is no progress without change. No one can doubt that the scientist and the engineer are to be the most important industrial figures of the near future. If we are faithful to our duties we shall be of greater importance politically and socially, but to accomplish this we must broaden our vision and get about our business, which is the industrial organization of our country.

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At the beginning of January the Ordnance Department of the U. S. Army opened up a headquarters in the rooms of the Society for the purpose of recruiting and commissioning officers qualifying for ordnance service. The recruiting officers were Major Fred J. Miller, Capt. Henry C. Phipps, and Lieut. M. Goedecke, who comprised the examining board. Utilizing the Society's "war classification list," the board secured names of members of the Society qualified for the particular duties the Ordnance Department needed and issued calls to them. The work was kept up for several days, during which time upward of 1000 men presented themselves for examination.

# POWER TEST HEARING AT ANNUAL MEETING

## An Account of the Proceedings of the First Public Discussion of the A.S.M.E. Rules for Conducting Performance Tests of Power Plant Apparatus, Issued in 1915

THE public meeting of the Power Test Committee was held on Friday, December 7, and was called to order by President Hollis at 10 o'clock. The immediate object of the hearing was to discuss the various testing codes as published by the Society, and the ultimate object was to aid the Power Test Committee in such revisions as might be needed to make the codes of the greatest service to the profession, and to bring them up to date.

The members of the Power Test Committee, originally numbering eight, but increased later to twelve, were invited to sit at a table in front of the audience, and the members of the Advisory Board, composed of Society members identified with manufacturers and users of power-plant apparatus, appointed by the Council and numbering fifteen, were asked to take seats in the front row. Nine members of the main committee and nine of the Advisory Board availed themselves of this invitation.

President Hollis then addressed the meeting on the object of the hearing. He said that codes such as those under discussion were growing and changing, and that in order to make them valuable to the country at large there must be constant amendments and additions, the need for which arose not through oversight on the part of the Committee, but rather through changes in the demands of business and the use of better and different instruments. Moreover, although there might be a great many methods of generating power, and therefore a number of codes needed, there should be some definite principle underlying them all. The codes, he said, belonged no longer to the Society, but to all users of power, and therefore should represent the best effort and experience obtainable.

President Hollis explained that a program had been arranged in accordance with which the discussions of the various codes would be taken up at scheduled hours in order that the hearing might be conducted systematically. This program was closely adhered to, with the exception of the latter part when it was found that less time was needed than had been planned.

Mr. George H. Barrus, Chairman of the Power Test Committee, then presented a statement of the history of the Committee and the objects for calling the present hearing. Those present had been provided with a printed copy of his statement, which included the personnel of the Committee and of the Advisory Board. He stated that special written invitations had been mailed to some sixty engineering societies, organizations and associations interested in the subjects to be discussed. Similar invitations were sent to about forty manufacturing concerns and trade organizations, fifteen railroads and twenty-five colleges. Special invitations were sent to prominent engineers not members of the Society, to the United States Bureau of Standards, and to the Navy Department Bureau of Steam Engineering. Over half of these invitations had been accepted.

President Hollis then threw open the meeting for the discussion of the first thirty-three paragraphs of the codes embodying the General Instructions. It was decided that the discussion proceed without the reading of the paragraphs, as everyone in the audience had a copy of the complete report. It was also decided to omit the reading of all written discussions, as these would be placed in the hands of the Committee.

The oral discussion was opened by Capt. T. W. Kinkaid, head of the Engineering Experiment Station at Annapolis. Captain Kinkaid read a statement prepared by the engineers of the Experiment Station dealing with the General Instructions. Comments were made on some twenty of the subjects.

The remainder of the discussion on the first 33 paragraphs referred to details of the present general instructions, including changes in wording, methods and use of instruments, measurements, calibrations and standards. Those taking part were Messrs. Moss, Moody, Delany, Reynolds, Kruesi, Allerton, Vennum, and Greene. Messrs. Hirshfeld and Sparrow thought there should be a complete revision of the whole subject, and the President suggested that this latter point of view might be put into concrete form by a committee representing those who believed in a complete revision. He pointed out that the Society was not bound to abide by what the Power Test Committee had published up to the present time if something better and more useful could be suggested. Prof. Arthur M. Greene, Jr., thought it would be best to defer any such action until the codes had all been discussed, and in this view the President finally concurred. No further reference was made to the subject during the hearing. A little later, however, Mr. Moss expressed a conviction that no such complete revision as that suggested by Mr. Hirshfeld was needed.

### Discussion of Code for Testing Boilers

At the request of the President, Captain Kinkaid continued with the portion of his discussion which related to the Code for Testing Boilers which was next in order for consideration.

E. B. Ricketts submitted to the Committee a form which he had used successfully for a number of years for reporting boiler tests and the instructions which were a part of the general scheme. He also included a chart from which many of the calculations of the boiler test could be made with a minimum of labor.

C. H. Delany made suggestions regarding tests of oil-fired boilers, and presented them to the Committee in written form. He wished the Code to include a separate tabulation for oil-fired boilers.

Prof. Charles R. Richards filed with the Committee a copy of a bulletin entitled A Study of Boiler Losses,[1] which included in an appendix a suggested code for boiler losses, a subject he considered inadequately handled in the present code.

R. Sanford Riley thought the rules for starting and stopping tests too definite for certain types of stokers where conditions in the fire were considerably different from those in hand-fired furnaces, Louis E. Strothman submitted a suggestion for the determination of boiler leakage, E. G. Bailey offered suggestions regarding the effect of the rate of steaming at the time of starting and stopping, and Captain Kinkaid presented some notes entitled, Correction for Difference in Quality of a Fuel Bed at the Beginning and at the End of a Coal Test.

[1] Bulletin No. 78, Engineering Experiment Station, University of Illinois, Urbana, Ill.

### STEAM-ENGINE CODE

Sanford A. Moss opened the discussion on the Steam-Engine Code by offering his criticisms and amendments to certain sections of the Appendix dealing with this code. He also suggested that the Steam-Turbine Code come first and that the Steam-Engine Code refer to it, as he thought more tests were made of turbines than of engines.

Prof. Charles R. Richards discussed parts of the code at length and William L. De Baufre and Prof. A. G. Christie submitted written discussions.

Louis E. Strothman also joined in the discussion.

### STEAM-TURBINE CODE

B. F. Tillson suggested the $CO_2$ method of tests in cases where no surface condenser was in use.

S. A. Moss objected to the use of anything but a mercury gage for determining vacuum. He gave his views regarding corrections for different vacuums.

Thomas E. Keating seemed to be of the opinion that the code had never been "adopted," inasmuch as engineers who tested turbines did not seem to use it. Apparently, he said, there was something wrong with it, and if so it should be revised. He offered no specific suggestions as to what sort of revision would be acceptable, but suggested that representatives of turbine builders and turbine users be called in to assist in laying out a new code.

Prof. Arthur M. Greene, Jr., thought that the code should include some method of correcting for changed conditions which could be used in the case of small turbines where the expense of running a series of tests to determine these corrections would be out of the question.

A. H. Kruesi and J. P. Sparrow spoke regarding methods of determining vacuum.

### PUMPING-ENGINE CODE

Frank F. Nickel submitted to the Committee a revised code. He was followed by Robert W. Allerton, who explained the need of a revised code from the standpoint of the use of centrifugal machinery. He also presented a scheme for making hydraulic measurements. In addition, he pleaded for a table of "terms" which would define absolutely such engineering terms as admit of several interpretations. Professor Greene also felt that an interpretation should be put upon certain terms by the Society so that an engineer might have an authority for his use of them.

At the close of this discussion, the meeting was adjourned for lunch, and reassembled at two o'clock with President Hollis again in the chair.

### COMPRESSOR AND BLOWER CODE

Hugh V. Conrad, Secretary of the Compressed Air Society, opened the discussion on the Compressor and Blower Code by presenting to the Committee a number of suggestions regarding measurement of air. He called attention to the method recommended in the present code for measuring air and suggested that the orifice method be substituted.

Sanford A. Moss thought that the code should provide for the testing of electrically driven units. He also started a discussion on the term "free air," which was participated in by S. B. Redfield and William L. De Baufre. Mr. De Baufre suggested the preparation of a separate code for blowers and fans, as he thought much confusion resulted in trying to apply the Compressor Code to them.

### STEAM-PLANT CODE

The Steam-Plant Code elicited discussion from George C. Vennum and Philip E. Reynolds criticizing the phraseology of the code and calling attention to some ambiguity of terms. They also felt that condensers and pumps were not properly treated, and therefore presented suggestions for amendments to the code covering condensers of various kinds, air-removal apparatus and cooling towers.

### LOCOMOTIVE CODE

The only speaker on the Locomotive Code was Prof. Charles R. Richards, who emphasized the need for incorporating some recognition of cinder losses. He also suggested that the Committee adopt the code used by the American Railway Master Mechanics' Association, and locomotive-testing experts be consulted.

### WATER-WHEEL CODE

Chairman Barrus opened the discussion on the Water-Wheel Code, the inadequacy of which seemed to be generally admitted by all speakers and interest in which seemed greatest of all. There were assembled in the audience as representative a group of hydraulic engineers, probably, as could be gathered together.

Chairman Barrus announced that the Committee had had under consideration for several months the work which was being done by the Turbine Builders' Association and the Machinery Builders' Society relative to standardizing the methods of conducting acceptance tests on hydraulic turbines, and that it had just received the official copy of the code which was the result of their work. This code, he said, would have the due consideration of the Committee and in many ways would be of assistance in their deliberations.

He also announced that at the invitation of the Council, the American Society of Civil Engineers, the American Institute of Electrical Engineers, and the National Electric Light Association had each appointed three representatives to confer with the Power Test Committee and to coöperate with them in the revision of the Water-Wheel Code. The conference was scheduled for the following week.

There seemed to be some delay in starting a discussion in which so many were not only interested but able to take intelligent part for the information of the Committee, until Lewis F. Moody called upon John L. Harper.

Mr. Harper said that until the present hearing his attention had never been called to the Water-Wheel Code. He pleaded for consistency of action in the various engineering societies interested in such a code if one was to be adopted, and seemed to feel that the basic need of any code was an accurate means of measuring water, suggesting, in spite of the difficulties which it apparently presented, the volumetric method. He was insistent in the statement that an adequate code, based upon correct principles, was an immediate necessity.

William M. White, who was interested in the code proposed by the Machinery Builders' Society, asserted that builders of water turbines had waited for years for some one to bring out a code under which they could make guarantees which they could carry out. He pointed out that the builders were interested in the measurement of water, but they did not care so much how it was measured as long as the turbine

was tested under the same conditions and with the use of the same weir coefficients as were assumed when the guarantee was made.

The remainder of the discussion, in which Messrs. Carle, Johnson, Moody, Allen, Herschel and Taylor took part, merely brought out the fact that all agreed as to the need of a revised code. To bring the matter to a head, Mr. White offered a resolution to the effect that it was the sense of the meeting that the code adopted by the Machinery Builders' Society was satisfactory and recommended it to the Committee for acceptance, but it was finally shown that the resolution was unnecessary.

### SUB-COMMITTEES ON CODES PROPOSED

Dr. Jacobus then spoke in the capacity of delegate from the Society of Naval Architects and Marine Engineers, suggesting the appointment of several sub-committees, each one of which was to have particular charge of a single test code, such as had already been done with reference to the Water-Wheel Code. The matter was put into the form of a resolution by Professor Allen to the effect that it was the sense of the meeting that such committees be appointed. The President assured the meeting that the Council would consider the resolution that very afternoon, and explained that it was the custom of the Council to consult with members of other societies on matters relating to their interests.

After considerable discussion, which centered around the relations of the subcommittees proposed, the Advisory Board and the Power Test Committee, the resolution was adopted.

During the discussion, N. A. Carle spoke of the American Engineering Standards Committee, of which he was a member. He said that the scheme of the committee was not the revision of standards but entirely that of acting as the connecting link between the societies and organizations who had established the standards. A standard, adopted by a society, would be referred to the committee for approval. If found acceptable to them, they would refer it to other societies interested in the subject considered, and upon universal approval, approve it as standard and recommend it for practice for one year. At the end of that time it would be stamped "American Engineering Standards." The result, he explained, would mean that some day it would be possible to say, "I want a power system of one million kilowatts capacity, American Engineering Standards."

President Hollis turned the chair over to Dr. Jacobus, who called upon Ervin G. Bailey to explain his system of measuring steam by means of carbon dioxide. The method, which is analogous to the salt-solution method used by hydraulic engineers for measuring water, was described in a paper presented to the Boston Section of the Society in May 1916.

The meeting closed with a discussion started by R. Sanford Riley on the errors in starting and stopping boiler tests. James W. Parker cited an extreme case of a test in which thirty tons of coal constituted the kindling fire, showing thereby the possibility of an enormous error which, he believed, could be avoided only by lengthening the duration of the test until the amounts of coal stored on the grates would bear an insignificant proportion to the total coal fired. Others agreed that this was a very uncertain element of any test, and expressed their belief that longer tests would avoid this error.

Chairman Jacobus asked for opinions on the question of sampling, and was answered by several members to the effect that the size of the sample should be as great as possible to insure the best results.

The object of the hearing having been accomplished and all of the codes disposed of, Chairman Jacobus adjourned the meeting at about 4:30 p.m.

# IMPORTANT DISCUSSION ON VARIED POWER PLANT SUBJECTS

## Proceedings of Session Devoted to Papers on Small Turbines, Waste of Coal, Bagasse as Fuel, Cooling of Water, and the Steam Motor

ONE of the busiest sessions of the Annual Meeting was the Power-Plant Session held on Wednesday afternoon, December 5, on the fifth floor of the Engineering Societies Building. Five papers, each one of them of sufficient importance to occupy the entire afternoon, were presented and discussed. Thanks to the enjoinder of the chairman, Mr. William B. Jackson, that all speakers carry the matters they wished to discuss well in their minds and come straight to the point, close attention was given to the work of the session and the long program was carried through very satisfactorily and without need of adjournment.

The five papers were on varied and timely topics in the power-plant field. They were all published in advance in THE JOURNAL and excited a wide interest, as evidenced by the large number of written discussions sent in prior to the meeting. The titles of the papers were: A Commercial Analysis of the Small-Turbine Situation, by W. J. A. London; Preventable Waste of Coal in the United States, by David Moffat Myers, member of the Committee of Consulting Engineers on Coal Conservation and Publicity coöperating with the Fuel Administrator; Bagasse as a Source of Fuel, by E. C. Freeland; The Cooling of Water for Power-Plant Purposes, by C. C. Thomas, and The Steam Motor in the Automotive Field, by E. T. Adams.

A running account of the discussion at the session, including pertinent abstracts from the written discussions, is given below. The full discussions, both oral and written, and the authors' final closures will be published in the TRANSACTIONS, together with the revised papers, as usual.

### A COMMERCIAL ANALYSIS OF THE SMALL-TURBINE SITUATION, BY W. J. A. LONDON

In his paper, which he presented in person, Mr. London developed a commercial analysis of the four types of small steam turbines now on the market and used for the driving of auxiliary machinery, dealing principally with non-condensing units. He said that in these high thermal efficiency is in many cases unnecessary on account of economic utilization of the exhaust steam, and as economy bears a definite relation to first cost, a highly efficient machine is often a mistaken investment. Moreover, operating conditions are generally such that the designer must sacrifice considerations of efficiency if they interfere in any measure with simplicity and durability.

The theoretical design, he thought, presented no difficulties, but the mechanical design is what determines success or absolute failure; and some of the problems involved and the

methods that have been employed in solving them successfully were indicated in the paper. Among these problems was that of alignment of the turbine with the driven unit, and in this connection he illustrated a two-bearing combined unit which has eliminated misalignment troubles.

He said that the average specification calls for very rigid guarantees as to steam consumption, speed regulation and load requirements that, in his opinion, are in most cases unnecessarily severe and merely tend to increase the cost of installation. After an extended survey of the situation, he was led to formulate a Code of Practice, given in an appendix to the paper. The adoption of this code would, he believed, bring about a reduction in selling prices, eliminate many of the unpleasant experiences which now often arise between manufacturers and customers, and thereby increase the popularity of the turbine-driven unit.

O. D. H. Bentley, in a written discussion, entered a defense of the type of turbine styled by the author as class "(*b*) Terry, Sturtevant and Bliss." He said that, other things being equal, the amount of energy a rotor will extract from the steam varies directly as the angular reversal. The author showed diagrammatically that the reversals in the rotor and redirecting chambers of the Terry, Sturtevant and Bliss turbines, all of which utilize the Riedler-Stumpf principle, were approximately 90 deg., but this was incorrect as the reversals were practically 180 deg. It was therefore fair to assume that this type of turbine will absorb practically double the amount of energy per reversal, compared with the Curtis.

Secondly, in the Riedler-Stumpf type, as the author states, the action is complex. This should not condemn the principle but on the other hand should indicate that even better efficiencies with this type are possible when the action is better understood. The Curtis principle has been highly developed, whereas the Riedler-Stumpf has not to date been given serious attention.

The author's statement that the Terry Company has recently developed Curtis machines would seem to indicate that they are abandoning the original Terry machine, whereas, as the writer understands it, the Terry machine is still used on small sizes while the Curtis principle is used for larger or condensing turbines only.

In regard to lining up a turbine and its driven members, he thought it was a comparatively easy matter to do this. It is more a question of education than of adapting a design to eliminate this necessity, thereby possibly getting into other troubles. Some difficulty has been experienced because engineers have assumed that it was not necessary to realign units, especially if they came mounted upon a self-contained cast-iron base and were connected by a flexible coupling. Experience has shown that after a turbine is once lined up it will retain its alignment indefinitely, provided, of course, it has a suitable foundation.

The majority of engineers seem to agree that it is more desirable to have any piece of high-speed apparatus mounted between two substantial bearings than it is to have it overhung There is no doubt, however, that the latter is cheaper, lighter and occupies less space. The primary consideration in machinery for auxiliary service is, however, reliability, and experience has shown that overhung elements are more sensitive to trouble than those supported between two bearings.

He considered the author's Suggested Code of Practice advantageous not only to the manufacturers but also the ultimate users, but he agreed that in order to apply the idea everyone must adopt and adhere to it.

A. G. Christie took a different view of efficiency to that presented by the author, though he admitted his view might not be consistent with commercial considerations. He wrote:

"This war is bringing home most emphatically to our American people the need of economy. To the engineer this means getting the greatest number of B.t.u. in useful work from each pound of coal burned. The days of cheap coal are fast passing, and with every dollar added to the cost of a ton of coal, the gain from the use of economizers increases. Hence, great impetus will be given to the installation of such equipment and to water-treating systems which will ensure economical operation of such economizers.

"Now, with economizers in a plant, the feedwater need be heated only to 100 instead of 210 deg. fahr. where feedwater heating by exhaust steam is now used. Hence, under such conditions less exhaust steam will be required; and when steam-driven auxiliaries are preferred to motor-driven units, their economy will be closely scrutinized. It may then be desirable to pay a little more for the more economical turbine auxiliary.

"Improvement of design is not wholly inconsistent with decreased cost of manufacture. In fact we have reason to expect our designers to improve their designs with increased knowledge of steam performance and blade materials and at the same time to cheapen their product.

"The small steam turbine usually employed in driving auxiliary machinery does not require much attention as a rule. It would therefore seem that the class of labor employed in looking after auxiliaries should not be a prime consideration in determining the efficiency of the turbine, as Mr. London would lead us to believe. Still, Mr. London is quite correct in insisting on simplicity and durability."

He said that the author's discussion of alignment is very timely and deals with a point that has been a source of great annoyance to purchasers of small turbines. It is to be hoped that manufacturers will take steps at once to finally overcome these difficulties, particularly in those cases where all equipment is not supplied by one party.

He agreed with Mr. London in regard to the unreasonable demands by some engineers for numerous guarantees on each small unit that they buy. He had often felt that these men lacked data in regard to turbine performance. The demands of engineers for guarantees would be simplified if manufacturers would loosen up on this data and let engineers become better acquainted with turbine performance under varying steam and back-pressure conditions and speeds.

Mr. London argued very vigorously for standard ratings of turbines. On a previous occasion, he had urged before the Society the desirability of fixing certain standards for rating steam turbines. It would be most desirable to decide whether the normal rating should be at maximum load or at some percentage of that load. He proposed to bring this matter before the Power Test Committee at its forthcoming meeting.

J. L. Moore, also in a written discussion, considered the author's classification of the present Kerr "Economy" turbine as an original type as misleading, since this turbine is of the Rateau type, consisting of a series of single-pressure stages. The original Kerr machine, designed by Mr. C. V. Kerr in 1904, was a multi-stage turbine, consisting of a series of single-pressure stages with a steam Pelton wheel in each stage. This turbine is no longer built, having been abandoned in favor of the Kerr "Economy" type, designed by himself about ten years ago. This turbine consists of a series of single-pressure stages, each stage having a set of nozzles and a single wheel; it is therefore of the Rateau type.

The author's statement that the Moore turbine is a modified

design of the Kerr is also erroneous and misleading, for the reason that the Moore single-stage turbine is of the Curtis type, while the multi-stage machine is of the Curtis-Rateau type. The mechanical details of the casing of the Moore multi-stage turbine are radically different from the Kerr Economy turbine.

The Terry is an original type, unless the Stumpf may have been designed previous to it. The Westinghouse single-stage type as built in small sizes is also an original type and was, he believed, designed by Mr. R. N. Ehrhart about fifteen years ago.

M. Nusim wrote that turbine development and progress have been very largely influenced by a demand for higher efficiencies, and this is also true so far as small units are concerned.

The Curtis-Rateau turbine, a composite type consisting of a first-stage wheel having two moving rows of buckets followed by a number of stages having a single bucket row per wheel, has been adopted very extensively for large units of all sizes, but by a proper selection of speed it is also being applied for sizes below 1000 hp. for either condensing or non-condensing turbines. This proper selection of speed is often accomplished by the use of reduction gearing so that standard speeds for modern units of capacities below 1000 hp. vary between 5000 and 7000 r.p.m., depending on size. With such speeds, and also with a proper selection of the number of stages, steam economies are possible with small units which were formerly obtained only with large turbines.

J. A. MacMurchy[1] contributed an extensive written discussion of a number of points in the paper. In many cases he agreed with the author, and his statements were in amplification rather than in criticism of those of the author. The following paragraphs are confined in the main to this writer's criticism, as being more significant in the present connection:

"Even more important than simplicity and durability of auxiliary apparatus is the question of reliability in operation. It is absolutely imperative that the turbines driving auxiliaries shall be such that there will be no question whatever of their operating continuously. Both simplicity and reliability of operation are vastly more important than high thermal efficiency, but a skilful designer should be able to obtain the necessary simplicity and reliability, and at the same time a very high efficiency. Efficiency and reliability are not by any means incompatible.

"The author states that forced lubrication is impracticable in small machines for general auxiliary purposes. This has not been my experience, and in later designs the firm with which I am connected is arranging to provide oil pumps for every size of turbine except on a few extremely small lighting sets where ball bearings are used. This adds slightly to the initial cost of the turbine, but the advantages fully justify the expenditure. Even in quite small turbines a small and very simple oil cooler is also justified.

"The author has not sufficiently emphasized the necessity of the governor being relatively very powerful, that is, for a given percentage of speed variation it should exert strong pull on the valve stem. The governor being such an extremely important element, it should receive the same ample lubrication as that provided for the bearings.

"We do not believe there is such a thing as a flexible coupling for high-speed apparatus. Some couplings are of course better than others, but my experience is that it is better to design the machine so that flexible couplings will not be necessary.

"The shafts of the ordinary pump and blower are much too light for direct connection to a turbine to form a two-bearing unit. In many cases the critical speed will be found to be below the running speed, and often so near the running speed as to cause trouble. In geared sets this is quite permissible because of the slow speeds at which the pumps and blowers usually run, and the greater ruggedness of the apparatus.

"The author expresses the opinion that the usual speed-variation requirements are too exacting, and while regulation within 2 per cent is obtainable with entire stability and no tendency to hunt, at the same time there is no necessity for so close regulation; and, in fact, in most cases it is quite undesirable.

"The author discusses the advisability of adoption of a maximum-rating standard. The purchaser, in ordering a turbine, should specify the steam pressure available at the throttle and the power required. The manufacturer should not be required to estimate how much this should be deviated from, and if he furnishes a turbine which meets contract conditions, it should be considered satisfactory."

"It is recommended that the machine be considered as having met its guarantees if the steam consumption on test be within 5 per cent of the guaranteed figures. I am at a loss to understand what possible advantage there can be in this 5 per cent leeway. With a clause of this kind in the specifications, bidders would merely deduct 5 per cent from their expected performance, and nobody is deceived except possibly the purchaser. It would be very much better to hold the manufacturers to specific water rates, and expect the manufacturer to have sufficient margin in his guarantees to take care of the variations in machines.

"The author recommends that oil rings be furnished on machines designed for forced lubrication. I can see no possible advantage in this requirement, and these bearings can be made much better if they are not complicated with oil rings."

Herbert B. Reynolds wrote that the author states that high thermal efficiency is unnecessary in the small turbine if all the exhaust steam is used. This is true if the exhaust steam is used for heating or in manufacturing processes where any deficiency in the exhaust steam would have to be made up by the use of live steam. However, in the case of a power station where the exhaust steam from the auxiliary turbines is used for heating the feedwater, the steam consumption of the small turbines plays an important part in the efficiency of the power station. It is true that the feedwater heater recovers all of the heat in the exhaust steam, but it does not recover the boiler losses which are incurred during the generation of the steam.

C. P. Crissey contributed a comprehensive written discussion in which he said that there is no doubt that in many cases needlessly severe guarantees are requested by purchasers of small turbines, and that the author has done a service in bringing this to general attention.

Any code of practice to be successful must first provide that the turbine meet the requirements of service, and not be primarily for the convenience of the manufacturer.

Regarding steam consumption, as a rule one guarantee point is sufficient; that is, the ultimate operator is fully protected by a guarantee at a single load, one speed and the given steam and exhaust conditions. If other load points are required they should not go below one-half load; quarter-load guarantees should not be required.

When guarantees are given on a condensing turbine, they should not be asked for under non-condensing conditions.

The purchaser is justified in requiring that certain loads be developed under abnormal conditions which are bound to occur. For instance, the author states that the output is reduced about

[1] Pittsburgh, Pa.

20 per cent when the steam pressure drops 10 lb., with an increase of 2 per cent moisture and a rise of 2 lb. back pressure. An experienced purchaser will state the load required and the average conditions of operation at which an economy guarantee is desired, and then specify that the load shall be carried at somewhat poorer conditions which he foresees are liable to occur in ordinary operation. If the purchaser is inexperienced the code should protect him by specifying that the maximum load must be developed if the steam pressure drops a certain percentage, this drop being sufficient to allow for a change in quality or reasonable change in exhaust condition. To meet this requirement the turbine should be supplied with a hand valve opening additional nozzle sections, which, when open, are under control of the valve gear. The cost of the addition is well worth while as a simple matter of insurance.

While economy guarantees on a condensing turbine operating non-condensing should not be required, it is quite reasonable in some instances to demand that a certain fraction of the rated output be developed non-condensing, the purchaser bearing in mind that the demand should not be greater than necessary to safeguard the actual operation of his plant.

It would also be well for a code to prohibit bearing temperatures of 250 deg. fahr.

There is absolutely no reason why the power requirements of pumps and blowers should not be known just as accurately as the outputs of turbines, and they are so known in properly conducted organizations.

It is quite possible to obtain satisfactory operation with a two-bearing unit having a small overhung turbine wheel, but it is a type which, in the nature of things, should be built by manufacturers of combined units. The case is entirely similar to the rigid frame and three-bearing units commended by Mr. London when both parts of the unit are built in one shop. When built by different parties the proposition is, as he says, entirely different. Whether the driven machine is generator, blower or pump, if trouble develops, neither one of the manufacturers or an arbitrator can determine at which door the fault lies.

There are very good reasons why units having four bearings and a coupling have not been more generally superseded by two- or three-bearing sets. This is best illustrated by turbine-driven pumps. In this case a multiplicity of pumps must be driven by a given size of turbine, and on the other hand a certain size of pump must be capable of being driven by several sizes of turbines to meet the demands of various services and customer's requirements. In many cases where economy is of prime importance gears must be interposed between the turbine and pump. It is therefore apparent that an overhung turbine with two bearings or a three-bearing set is an obstruction to producing sets upon a manufacturing basis. Practically every set is a new design that requires careful calculation to prevent trouble from critical speeds or deflection of the wheel which will cause rubbing of the buckets. All this is true when both machines are produced in the same shop. If manufactured in different shops, lengthy correspondence is required to determine whether the pump manufacturer can increase the size of shaft through impellers and bearings to carry a heavier turbine wheel, etc. As no customer is going to wait upon such determinations, it follows that the average agent and some manufacturers will take a chance, with the result that the customer receives an untried and, in many cases, thoroughly unsatisfactory unit.

Customers should guard themselves against two- or three-bearing units that have not been operated with the same distances between bearings, the same diameter of shaft and the same loads upon the shaft, especially when the responsibility is divided between two manufacturers.

The author replied to Mr. Bentley that the relative angle of the steam on the wheel of the Terry type was not 180 deg. He indicated on the blackboard just what the angle was.

Replying to the discussions upon lining up units, he said that two or three pump manufacturers he had talked to had stated that "of the troubles reported in our plants, 90 per cent were directly or indirectly due to faulty lining up of the machine." He considered this matter of lining up a serious proposition.

Mr. Nusim brought up the question of consumption and cost. The water rate has a direct bearing on the cost, and it is a question whether it is more economical to pay for the most highly efficient machine or a cheaper machine. Small turbines can be made much more efficient if the customer will pay the price.

In reply to Mr. MacMurchy he said that adding an overhung rotor puts up the critical speed of the combination.

A five per cent variation in the guarantee would save a lot of trouble. In Europe it is standard practice, even in the larger machines, that all guarantees are accepted or rejected on the basis of 2 per cent either way.

He thought that forced-feed lubrication is an additional complication to be avoided on small turbines. On the other hand, oil rings are a good thing, because with them you are sure of getting oil in the bearings, and they guarantee a supply of oil to the machine in starting up.

## PREVENTABLE WASTE OF COAL IN THE UNITED STATES, BY DAVID MOFFAT MYERS

In the second paper of the session, David Moffat Myers endeavored to show how, by employing proper operating methods in boiler plants, it is easily possible to save at least 10 per cent of the coal now burned for steam-making purposes. Such a saving would release cars for other service equivalent, say, to the coal-carrying capacity of the Pennsylvania Railroad lines east of Pittsburgh, equal to 1,000,000 fifty-ton carloads per year, and the direct money saving to the industries would be around a quarter of a billion dollars, figuring the coal at $5 a ton.

The author stated that the object of the paper was to open a discussion which, he hoped, would lead to the formulation by the Society of definite recommendations of means for the reduction of the present great preventable waste of fuel in our industries, largely through faulty, careless and uninformed operation of boiler plants, and to the offering of the services of the Society to the Government for the organization, furthering, and, as far as possible, execution of the plan which may as a consequence be adopted.

He presented two plans which he thought worthy of consideration. "The one might be termed the autocratic method. This would involve the use of authority to compel coal consumers to execute such measures of economy as the proper authorities might prescribe for any given case, limits to be set as to expense to the user. Such limits might be in terms of a percentage of his present yearly coal bill. Alterations should be directed chiefly to purely operating improvements. Many objections would probably be made by consumers against this plan, but once in effect the majority would no doubt realize its pecuniary advantage to themselves. But its tendency might be too strongly opposed to democratic principles.

"The other plan would be largely an educational one, in which patriotism and efficiency would furnish the motive forces required. The teaching must be accomplished with the

utmost simplicity and directness. This is a big task, but with the technical and executive ability represented in this Society, these things may be accomplished.

"The requisite information much reach the owners and managers of industries, and there must be simple instruction sheets for the engineers and firemen. The vital importance of daily accurate records of coal and water must be taught and information given regarding practical appliances for automatic measurements of both.

"Blank forms might be sent in advance to plant owners in order to be advised by them, first, whether they would be willing to coöperate with a governmental organization offering to assist them in reducing their coal consumption, and second, to obtain such data as to size, type, equipment, operation and fuel consumption of the plants as would enable a classification which would permit a Government board of experts to send such instructions as would include the information needed for any one class of plants."

It is significant that in all the voluminous discussion which this paper brought out, there was practically no disagreement whatever with the author's statements in regard to the waste of coal. Seemingly, almost everyone took these statements for granted, and the trend of the discussion was to emphasize the need of either the author's "autocratic" or "educational" methods of saving coal, or else to describe some other plans for accomplishing the same end. Many of the discussers gave examples of how they had secured results in particular cases, contributory to the one great result desired by all—saving the ten per cent of our coal used for steam making, which, in turn, is two-thirds of our total production.

Walter N. Polakov wrote that of the author's two plans the first one is so unfortunately worded as to create prejudice against it. It reads ". . . the use of authority to compel coal consumers to execute such measures of economy as the proper authority might prescribe in any given case." The plan really means *the abolition of privilege to waste fuel in inefficiently conducted plants, by giving priority in coal deliveries to those who prove that they do use it efficiently.*

This priority can be determined by:

1 Rating by experts (nominated by the national engineering societies and supported by public opinion and the Government) of plants in the indispensable industries which are entitled, because of coal-saving methods in use, to priority in coal supply.

2 Receiving of applications by a special service bureau of The American Society of Mechanical Engineers, from the low-rated plants for assigning the expert help.

3 Serving the needs of such inefficient plants by offering services of recognized experts in power-plant management for direction of the work.

4 Organizing a staff of steam, electrical and combustion engineers, whose members will be assigned to carry out the work in the plants of the applicants under the direction and supervision of experts.

5 Charging for such services an adequate compensation to cover the expenses involved (salaries, traveling and office) but no profit.

Mr. Myers's second plan, "an educational one, in which patriotism and efficiency would furnish the motive forces required," Mr. Polakov thought, is doomed to failure for the following reasons:

*a* Teaching efficiency by a correspondence-school method will accomplish little good, is incompatible with the professional dignity of this Society and lacks the personal touch.

*b* Endless variety of equipment, grades of fuel available, personality of men, nature of load, climatic conditions, etc., make the preparation of "simple instruction sheets for engineers and firemen" impossible, and if these are made they are so general as to be useless.

*c* No instructions of real value could be given unless examination of the plant was made.

*d* Keeping records, logs, etc., necessitates instrument equipment and measuring devices. All of this is good only when the data are used and interpreted by a trained man and this is done continually. Too many plants have no instruments at all; most of those that have keep them as ornaments due to the lack of proper organization.

*e* If the regular employees failed to secure high efficiency it is not because of the lack of "circularized education" but chiefly on account of 1, lack of time to carry out investigations and tests, all the time being absorbed by routine duties; 2, absence of instruments, facilities or encouragement; 3, lack of experience in this highly specialized line of research work.

*f* The education should begin with the owners and managers, not with the firemen.

*g* The very principle of "teaching" and "instructions" given to manufacturers and plant owners by the Society is undemocratic and un-American. They do not want or need to get something for nothing. Producing for the country but not without profit, they can prefer to pay for what they get if the benefit is commensurate with the expense.

*h* "Educational" talks and circulars usually degenerate into debating societies wasting time needed for deeds.

*i* Any half-measures with good intentions falling short of accomplishing valuable results are dangerous, as they chloroform the public conscience.

To sum up, the problem is to be solved by groups and individuals available through this Society for the service of those who know that more power can be gotten out of a pound of coal. There is no necessity of compelling plant owners to improve their methods, since in such a step lies their self-preservation. But there is an urgent necessity from the national standpoint to conserve the fuel by preventing its waste by ignorance or indifference. The valuation of plant methods to establish ratings for priority in coal deliveries is therefore recommended.

Percival R. Moses,[1] in a written discussion sent in subsequent to the meeting, described still another method whereby a saving in the amount of fuel burned may be obtained, greatly in excess of that which may be obtained by improvement of the individual plant. Broadly put, the saving would be effected by shutting down the inefficient plant and obtaining the power supplied from such plants from an efficient source.

Emmett B. Carter agreed with Mr. Myers's idea of a campaign of education among the firemen, but thought that we should feel some hesitancy in recommending the establishment of a bureau of such magnitude as would be required to carry on the work proposed, because we lack the men. The bureau will mean a very large force of men, valuable technical men, who can ill be spared now from other important work.

It is this same lack of intelligent men which is causing the waste of so much of our coal in the first place. Almost one-half of the coal being consumed for steam is used by the railroads, and the great problem confronting the railroads now is not how to burn the coal economically, but how to get the men to burn the coal at all.

[1] 366 Fifth Ave., N. Y.

C. R. Weymouth wrote that in his opinion the possible saving in coal consumption due to increased boiler efficiency would be materially less than stated by Mr. Myers. The biggest coal users of today were the mammoth public-utility companies, who had already been compelled to employ the best brains available and boiler-room efficiency engineers as well to maintain their economy of power production at a maximum, and it was inconceivable to him that they could save 10 per cent in their fuel consumption, or even half of that amount. There were no doubt many smaller users of power where the yearly bill was such that they were not warranted in employing an efficiency engineer, and in these plants a saving would be possible if expert service were available.

Mr. Weymouth suggested the formation of a committee of engineers representing the various classes of coal users, and familiar with this subject, to make a preliminary canvass of the situation from the data available, including census reports. The findings of this committee would indicate the extent to which this subject should be further investigated and recommendations made to the Federal Fuel Administrator. This investigation should also cover the question of availability of engineers and fuel experts to give instructions as to the better firing methods, should it be found that a large fuel saving is possible. His observations indicated that nearly all mechanical engineers are busy in some department or other in connection with the war, or vital industries, and that comparatively few men will be available to carry on a fuel-saving compaign, even should it be found that such a campaign might give beneficial results.

Whether the committee's findings indicate that a large fuel saving could be made, all engineers will agree that a campaign of some character should be made to reduce the waste of coal. Mr. Myers's suggestion that instructions be issued to firemen in simple language is a very timely one. We have had textbooks and technical papers almost without limit prepared for the benefit of technically trained men; but there has never been, to his knowledge, a suitable primer giving the elementary principles of combustion and the essential knowledge for a fireman. The preparation of such a primer could be well undertaken by the committee proposed, and it could be given wide circulation with surely beneficial results.

Any attempt to curtail the coal supply as a means of compulsory increase in boiler efficiency would, to his mind, lead to a chaotic condition. Whatever is done must be done voluntarily, at least initially. Variations in load factor, rate of demand, etc., complications of red tape, are such that any limitation of the quantity of coal supplied a given user would likely give rise to regrettable complications and curtailment of necessary output.

While there are minor improvements in boiler plants which can be made at this time, it must be borne in mind that the present-day trend in increased economy of fuel calls for higher steam pressures, higher degrees of superheat, larger prime movers, centralized generating stations—things which, if now generally put into effect, would immediately tax certain manufacturing facilities which should be left undisturbed for the production of the war's necessities.

A. F. Graves[1] gave an interesting example of what could be done in a specific plant, even in one which had always taken pride in boiler-room economy.

An instrument board was installed in the boiler room, with water- and steam-flow meters, temperature recorders and draft gages. With this means of studying all conditions, series of tests were run on the boilers for the purpose of finding the most efficient operating conditions at all loads, and printed instructions issued to the firemen so that they could always maintain these conditions. By this means a saving of about 12 per cent of the coal bill has been made. Possibly some ammunition factory is using that very coal to make the rifles that will help to put "our boys" over the top.

All lines of manufacturing must be kept moving, and with the present car shortage, the *knowing how* to prevent waste of coal would do much to keep up the supply.

It seems only fair to rate a plant for its wastefulness as well as its economy, and that the plant which can burn the coal most efficiently should have priority in coal deliveries.

R. K. Goodlatte[1] expressed as his written opinion that great good would be accomplished if the Society, backed by the Fuel Administration Board, would inaugurate an active campaign toward the end of preventing waste in industrial plants.

He suggested publishing posters giving simple instructions for hand and stoker firing, cleaning of fires, watching scale prevention, coal weighing, water measuring, etc. These instructions could be made vital and forceful by periodical visits by practical men with authority to enforce them, if necessary, under threat of coal-supply regulation.

E. P. Roberts suggested two ways of saving fuel—reducing the smoke loss by correct design and operation, remembering that the loss due to smoke from bituminous coal burned in towns and cities is seldom less than $1.50 per ton, and adopting "sensible heating."

Sensible heating is heating that satisfies the senses rather than the dry-bulb thermometer. Sensible heating is paying proper attention to humidity, securing the result of lower thermometer (dry-bulb), greater comfort, better health, lower fuel bill, etc.

Albert A. Cary, in an extensive written discussion, alluded to the author's statement that "The saving or wasting of one-fourth of the coal consumption of any industrial plant depends *entirely* upon the efficiency of its operating management" as the text upon which the balance of his paper is founded. He continued:

"In order to secure the desired conservation of fuels in such plants, Mr. Myers advises the services of the expert in operating management, by compulsion or otherwise; he suggests what Mr. Polakov has aptly termed a correspondence-school course, which, in the light of our experience, is not a wholly worthy suggestion.

"The expert in operating management—provided he is properly qualified and thoroughly understands his business, including the proper handling of the fuel used—can undoubtedly secure very desirable fuel savings; but his efficiency depends very largely upon the coöperation he receives from the plant owners and their employees, as well as their willingness to equip their plant with all the needed apparatus and to maintain and use them continuously after the expert concludes his work.

"Aside from the training of a boiler-room force by such experts, there are other matters which cannot be relegated to a second place of importance in considering the requirements for reducing the waste of fuel.

"Proper furnace design and construction, adapted to the use of the particular kind of quality of fuel used, furnish unquestionably the very keynote of the whole question of fuel conservation. By the term *furnace design* in a boiler equipment is included not only the furnace with its equipment, but

[1] Strathmore Paper Co., Mittineague, Mass.

[1] Delawanna, N. J.

also the entire boiler setting, flue and draft-producing equipment.

"Let us concentrate with greater earnestness upon the design and construction of our furnaces. Let us study our available refractories for furnace linings with greater care, as well as the high-temperature cements, the mortar used, and the red bricks used to enclose our settings.

"After equipping our plant with proper furnace settings which are adapted to produce the highest possible efficiency with the particular fuel available, our expert in operating management can come into the plant and do his most efficient work by instructing the men how to operate the furnaces in the most efficient manner. He can train them in the use of the instruments required to keep the plant constantly in its highest operating conditions, and there are many other needed duties requiring his attention to produce the most economical and requisite results which will reduce the amount of fuel and labor required.

"Turning now to the personal factor which enters so strongly into our fuel-economy problem: In our larger central power stations, the men who handle the coal and operate the boilers have been well trained, and they generally know that they *must* obey instructions or lose their jobs. In the smaller plants, we find a wide variety of firemen, some of whom are splendid fellows, who are anxious to learn, and those who take a pride in their work; while others strongly resent the intrusion of an outsider to show them how to operate their plant more economically. This latter class is responsible for the largest wastes of fuel occurring in steam plants.

"Many of these men are certainly not fitted for the position of firemen, and, unfortunately, many employers seem to think that the only qualifications needed are that they be strong, husky men, who can stand up before a hot fire and shovel in a lot of coal every time the furnace door is opened, and then to pull out the ash and clinkers from the grates or ashpit once a day.

"In order to stop our enormous coal wastes in industrial and other plants, these so-called firemen are the first men we should get under control, and, after giving this matter considerable thought, I have reached the conclusion that there is one way in which this can be done practically.

"To meet the present emergency, I propose that the War Coal Board take the necessary measures to bring all the firemen in this country under their control by requiring the firemen to take out and hold a United States license.

"The applicants for these licenses must show some qualifications which would entitle them to hold such privileges, but it is doubtful whether it would be possible, at the beginning, to have all of these applicants examined before qualified examination boards.

"Future applicants should be required to pass an examination before such boards, and qualify in a satisfactory manner before receiving their licenses.

"By this means, a better class of men will gradually displace the many fuel-wasting incompetents who are now disgracing the firemen's trade.

"This process would thus tend to 'weed out' the incompetent men who are keeping good, deserving and competent firemen out of jobs which belong to them, and thus, eventually, the status of the firemen would be raised, and their better fuel-saving work will merit them a higher rate of wages, which the owner can well afford to pay out of such savings effected in his steam plant.

"On the other hand, the stubborn, unpatriotic, penny-wise and pound-foolish owners of coal-burning plants, where glaringly wasteful conditions exist—who refuse to spend a cent to better their conditions and 'do their bit' in the conservation of fuel in this time of need—will meet with a rude awakening, and they will learn a lesson which will ultimately result greatly to their advantage and save them many dollars which would otherwise be hurled up their chimneys.

"This proposed method is now but a war measure, but after the war it is bound to result in a great benefit to the owners of coal-burning plants and to the country at large."

Lewis S. Maxfield suggested that the Government perfect the use of our peat deposits and deliver this fuel to the industries with instructions as to its proper use, instead of trying to make our industries do with less of the very first element of their existence. With the present high cost of labor and materials few power plants are in a position to undertake extensive improvements which would render them more efficient in the use of coal.

We have extensive peat bogs, the amount of combustible matter in which, it is estimated, exceeds that in all our known coal deposits. Peat is being used extensively in Europe as a fuel, and several large industrial plants report satisfactory operation with it.

The most successful method of utilizing peat at present seems to be in the gas producer, which will handle peat with a moisture content of 30 to 35 per cent, which is obtainable by air drying.

He admitted that many difficulties were met with in the use of peat, and as its use extended other problems would come up, but he thought they would be solved as have those incident to the use of coal.

John E. Muhlfeld considered that the autocratic and educational plans of procedure outlined were not in themselves sufficient for the consumers of coal to use as a basis for authorizing the capital expenditures that will, in the majority of cases, have to be made in order to produce the desired results and thereby secure an adequate financial return on the investment to be made.

Furthermore, particular stress should be laid on the fact that the more effective use of fuel should and can be made to bring about improved conditions in plant operation and labor, as well as conservation in fuel and financial returns.

Each power plant is, in itself, an individual engineering problem, and blanket instructions and advices cannot be of the greatest value.

There is no lack of patriotism among the coal users and the engineers of this country, and he doubted if any of them are "selling the United States short," but localized engineering improvements and supervision along practical lines for the purpose of modernizing plant equipment, and its maintenance and operation, are essential for the greatest accomplishment.

The scope of the procedure for the conservation of coal, steam-railway facilities and labor could be materially broadened by including

*a* The utilization of existing by-products of mining operations that are useful for steam-generating purposes, but which are now being wasted.

*b* The development and use of vast deposits of sub-bituminous coals and lignites lying adjacent to steam-railway lines.

The fact that one of our allies, Brazil, has recently, through the efforts of its government engineers, made possible the effective and economical use of its native coal, which has heretofore been deemed practically worthless, and thereby diminished its dependence upon imported coal for railway operation and industrial development, is worthy of our serious consideration.

The amount of useful coal now being wasted through existing methods of mining is great enough to more than offset the present shortage, and the reclamation and utilization of this by-product, for which labor, material and plant for mining have already been employed, in conjunction with the development of new sources of coal and lignite supply tributary to the points of consumption, are of paramount importance.

B. G. Elliott described the method employed by the University of Wisconsin to reach the firemen and engineers in power plants by means of lectures, demonstrations, and class-study groups.

The firemen and engineers are organized in a class group and are met each week by a traveling instructor who lectures and demonstrates to them on the various problems connected with the economical combustion of fuel. The class groups usually meet for a period of eight to ten weeks. At the end of the class and lecture work, the members of the class are usually gotten together for a boiler test conducted according to the best modern practice. This test is held at one of the plants of the community, the apparatus and recording devices being sent from the University. The men are required to work up the test on specially prepared forms.

When there has not been a demand for an extended class course, the subject is presented by means of an individual lecture and demonstration on coal, its composition and combustion. The manufacturers and the business men, as well as the firemen, are invited to attend this lecture, which has proved to be a very effective method of bringing the problem before this group of men who are interested more from a financial than from a technical point of view.

Michael M. Podolsky[1] proposed a "coöperative" plan for solving the fuel problem, the plan to be under the control and supervision of the Government, but to be under the management of specialists nominated by the Society in conjunction with the mining, electrical and chemical engineers.

The main feature of his plan was the organization by the fuel consumers of a national society for fuel saving, the work of which would be carried on by each member contributing annually on the basis of, say, 5 to 7 cents per ton of coal consumed.

The functions of this society would be mainly to disseminate information regarding fuel saving, to provide help to the Fuel Administrator, to recommend to the Government steps for relieving and preventing fuel shortage, to investigate and report upon new methods for saving coal, to establish special schools for firemen, to hold exhibitions and give prizes for best inventions and to aid inventors of fuel-saving devices.

The work of such a society would be under the direction of a council and would be carried out under its direction by a manager and staff.

This discusser voiced as his belief that only by the fullest coöperation between the Government, the coal consumers and the engineers on the widest scale could the fuel problem be solved. Notwithstanding the meager development of the coöperative idea in this country, the A.S.M.E. could institute such a coöperative method as described with the greatest practical results. He suggested appointing a committee to consider the plans presented in the paper and discussions and draw up a war plan, perhaps in collaboration with the Federal Fuel Administrator.

William L. Cathcart wrote that the United States is now the leading coal-producing country. Two-thirds of our total production is burned for steam making, with an approximate waste—as Mr. Myers very conservatively estimates—of 10 per cent, through lack of efficiency in the operation of boiler furnaces. That is, with the war industries of our French and Italian allies retarded and their civilian population freezing from lack of coal, we are wasting about 50 million tons a year.

It is a truism to say that this is an engineer's war, and, in many of its most important features, a mechanical engineer's war, both on land and sea. So, for the prevention of this huge waste, this colosssal drain on the war energy of our allies and ourselves, our Government officials may rightfully look to the membership of this Society for information and suggestions leading to a definite remedial plan.

The paper presented by Mr. Myers covers broadly the whole problem of fuel economy, as applied to steam making on land. In the writer's view, a specific program developed from it, and based upon it, is what is needed urgently, not only for the prosecution of our own war aims, but for sorely needed aid to our allies—a need that will increase steadily until victory is won.

It should be noted, too, that the economies produced from the execution of such a program would be *permanent*, lasting after the war, an enforced lesson in the value of fuel economy.

America is not alone in her prodigal waste of fuel. Sydney Brooks says: "There is very good reason, therefore, why Great Britain should observe the utmost care and economy in her methods of getting coal and of using it, and in her management of the entire coal industry. So far, her methods have been those of shiftlessness and improvidence."

But, if Britain can learn, so can we. Our trouble is not unwillingness. It is simply indifference as to the value of fuel economy. And, so far as the adoption of proper remedial measures is concerned—although specifically the user will profit—it is now broadly a question of patriotism, and the managers of our industrial plants will scarcely be lacking in that.

However, there might readily be a fair number of cases in which it would be difficult to secure compliance with a mere official request to adopt methods of fuel economy. Further, the education of firemen alone scarcely seems to be a practicable solution. The pressure on those firemen for that education should come from the owners and managers of their plants. This sort of efficiency grows best from the top down, not from the bottom up.

In the relatively few cases in which it might be necessary to bring pressure on owners or managers, Mr. Myers's comment suggests the necessary "big stick." Let the Government allow them only a quarterly or yearly amount of coal which will produce, when burned with full economy, the number of pounds of steam they require normally. If they choose to waste their allowance, let them shut down until they get their next allowance. The rigid control which the Government is now exercising, through the Federal Trade Commission, on the newsprint industry should be a lesson to such possible recalcitrants. These are war times, not the lax days of peace.

L. P. Breckenridge, Chairman of the Committee of Consulting Engineers on Coal Conservation and Publicity coöperating with the Bureau of Mines and the Federal Fuel Administrator, said that the ideas presented in the paper and discussions were excellent, but the question was whether they were immediately available. We must save coal and save it quickly, and anyone with suggestions should send them to Mr. O. P. Hood, at the U. S. Bureau of Mines, or to himself.

He said that Dr. Garfield, U. S. Fuel Administrator, was now preparing material to send out broadcast emphasizing the very great necessity of saving coal. Engineers should coöpe-

[1] Standard Steel Works Co., Burnham, Pa.

rate in this campaign, preferably through the representative of the Fuel Administrator in each state.

As examples of what could be done in this connection, the engineers of the Experiment Station of the University of Illinois have sent out valuable material regarding the use of the coal consumed largely in Illinois. The Fuel Administrator of Illinois should have the assistance of these men. The engineers in Connecticut, Virginia, Pennsylvania, and other states should similarly coöperate with the fuel administrators of these states, and much good will result.

Wherever engineering societies exist, some plan should be started, with the slogan "help save coal." Get in touch with the state or the city fuel administrator and offer aid. Get Government bulletins from the Bureau of Mines and distribute them at a lecture to "owners, managers and firemen." Help the local papers select facts and help them avoid "fiction." The important thing is to get sound directions to the fellow who is handling the shovel both in the home and in the factory.

Norman G. Reinicker agreed with all that had been said about operation, but considered that the biggest gain was not in operation but in design. Given a plant and the conditions to operate under, the results are probably 85 per cent due to design and 15 per cent to operation. He thought it was unfortunate that we should have reached the stage of having to save coal now, when we might have saved it a long time ago when plants were originally built, by putting in the proper apparatus.

In designing or remodeling a plant we should take into our confidence the manufacturers of the apparatus. They can give very valuable suggestions.

Improvement in designing does not refer alone to coal saving, but also labor saving. If we can build an ashpit that will hold 24 hours' ashes, instead of holding only one dump and requiring a man to be on duty during the whole of the 24 hours to handle the ashes, we can save considerable labor.

Even at the present time we can make our biggest saving, possibly, by changing the apparatus—scrapping some of the old stuff. It is a bad time to do it, of course, because the manufacturers are loaded down with other orders, but we should try to slip in some of these orders for new apparatus from time to time.

Waldron C. Beekley emphasized the extended use of exhaust steam in process heating as a means of fuel conservation. By putting in apparatus to properly use exhaust steam in heating water for various processes, the coal consumption can be reduced 30 per cent.

He noticed in Mr. Myers's paper a suggestion that the Society present some recommendations to the Government in regard to the way in which this fuel problem could be met, and he thought it would be very desirable if the above point could be followed up.

J. S. Lane said that the author's statement: "It is evident that we now require an extension of the idea of education, but in such form as directly to affect the men who run the boiler plants of our country, for in their hands is the saving or wasting of one-fourth of the fuel which they consume," was made just as though these men had the matter all in their hands; and, while it is true they do have a good deal in their hands, yet Mr. Cary hit the nail on the head in wanting the right furnaces and the right apparatus. Even though you teach the average fireman the best ways of firing, when your back is turned he will go back to his old way.

Many boiler plants both small and large are now fitted with appliances that automatically and continuously maintain balanced-draft conditions in the furnace, supplying just the right amount of air required for combustion, maintaining a uniform steam pressure, and allowing the hot gases the longest possible contact with the heating surfaces of the boiler; and a further elimination of the human element can be effected by the use of a mechanical stoker, automatically controlled by the balanced-draft regulator so that the feed of fuel is varied in proportion to the supply of air.

The author also speaks of the railroads, saying "We are now threatened with a serious coal shortage due chiefly to the overstrained carrying capacity of the railroads." It is believed, however, that if the known methods of saving fuel are employed, thus relieving the railroads from carrying some of it and leaving the saved part in the ground for the use of those who are to come afterward instead of burning it all up now, railroads, coal users, and the general public will be benefited.

Edward N. Trump said there was one way of reaching the man who shovels the coal into the furnace which had not been touched on, and that is to make it to his interest to save the coal. He had found in increasing the efficiency of their coal plants from 50 per cent, which they used to consider fairly good, to 85 per cent, a very large part of that increase was produced by making it of interest to the men who did the work to produce these economical results.

If you give a bonus to your fireman, you will be sure to have some result. He had found at least ten per cent saving by paying a bonus to the fireman, and also by working one shift against the other, that is to say, making it to their interest to improve the saving.

Installing such a plan has not proved difficult. If you have the necessary instruments you can, in the first place, determine the amount of carbonic acid in the waste gases. You can measure the water. In addition, you can take samples of the ashes and determine the amount of carbon. If at the end of a month, having these three things, you work out the efficiency from these items, and work each shift, one against the other, you will get results which will be surprising—save at least ten per cent of the fuel with the same apparatus and without any changes whatever.

Combustion is a chemical phenomenon and can be diagnosed and controlled only by chemical means; and you have to have apparatus to do that; and it ought to be so that the fireman can tell instantly, so that it shows right on the front of every boiler, what the condition of his fire is; and that, in addition to all of the other things which have been brought up, will bring the maximum efficiency.

The chairman said there is another phase of this situation, and that is the fact that we are endeavoring to work out a plan by which concrete, nation-wide propaganda can be put into operation, taking into account thousands and thousands of power plants. Furthermore, we have a situation at the present day complicating the normal conditions enormously in that the personnel of our fireroom forces is in a condition of ferment—our manufacturers do not know today how many of the men who are in their plants will be with them tomorrow; and to carry the thing further, they have not the slightest idea as to how many of their trained firemen, and their firemen who know their equipment, they will have two or three months hence. Consequently, we have some added critical and difficult aspects of the subject, but that is no reason why the Society should not do everything in its power to work out the best that can be done in this matter. He was personally inclined to believe that with collective coöperation we ought to

be able to do everything Mr. Myers has said, and possibly do a shade better.

The author in closing the discussion stated that he was surprised that some of the discussers did not understand the relation between equipment and operation in their effect upon efficiency. There is a mathematical equation which expresses this relation, which is as follows: Efficiency in any process is equal to the efficiency of the mechanical equipment multiplied by the efficiency of the human factor. This may be expressed: Efficiency equals $E \times H$. For example, in the matter of fuel economy, if we have a furnace perfectly designed and adapted for a specified fuel and purpose, we may regard our equipment as having an efficiency of 100 per cent, but if the man who operates the furnace is drunk, the efficiency of the operation will be zero.

Take it the other way around, and suppose we have a perfect fireman but the grate has fallen out of the furnace: our efficiency will again be zero. Thus, as stated, the formula $E \times H$ truly expresses the relation between equipment and operation in determining the efficiency of any process.

Consequently we must of course endeavor to obtain the highest attainable efficiency both of equipment and of operation, in order to realize the maximum of combined or ultimate efficiency.

The point of all this is that by improving the efficiency of operation alone, the combined efficiency is susceptible of great and immediate improvement. Without loss of time and without expenditure for new or changed equipment, an average saving of 10 to 20 per cent of coal can be effected in factory boiler plants. Therefore, in a fuel-saving campaign, adequate measures must be directed first toward obtaining the maximum improvement possible in the way of purely operating economies. Later, the equipment side of the proposition should be given urgent attention.

The immediate problem before us is to develop ways and means for putting into effect these economies which I have shown may equal 50 million to 100 million tons of coal saved per year. These savings may go into effect at once.

I regret that the greatest volume of discussion on my paper has been directed toward technicalities. All competent engineers who have studied the fuel problem know the technical side of the situation, and if I had been allowed the time and space, I could have presented all of the technical information and suggestions which have been involved in this discussion. All good fuel engineers know these things; the bad ones do not count.

The present situation does not call for technical discussion but it does call for *ways and means* for putting into effect the knowledge which we now have and in such a manner as to save the 50 million to 100 million tons of coal per year which can be saved. A few very interesting suggestions on ways and means have been brought forward in the discussion.

Let me first state most emphatically that education will comprise an essential feature in the campaign for saving coal which will be adopted and successfully prosecuted in this country: education of the owner, education of the firemen.

Incentive must be added to education so that manufacturers and owners will *desire* to coöperate in the fuel-saving campaign. It is probable that for the most part patriotism and efficiency will provide sufficient incentive, but to this may be added the shutting-down of inefficient plants in case of necessity. It would not be fair to the highly efficient plants to cut off their coal supply while wasteful plants were literally throwing away coal. The whole question resolves itself into that of ways and means for executing the measures of economy which all fuel engineers know are necessary at this time. It is desirable to work as far as possible through existing agencies and organizations. For instance, the federal, state and local chambers of commerce are already working along these lines to some extent and they should be encouraged and helped from headquarters by bulletins on fuel economy, the furnishing of lecturers, starting of schools for firemen, etc. Then the manufacturers' associations will be of very great value. They should be urged to pledge themselves to a campaign of fuel economy in their respective localities. They should get together for meetings devoted to the subject; they should obtain the best fuel engineers in their vicinity to lecture to them; they should get the services of these men to visit their plants and make suggestions and adopt further sensible plans for saving fuel.

Any plant owner who failed actively to install methods for economizing in the use of fuel in his plant would be considered a bad citizen by the other members of his association who would be working for governmental interests. This bad citizen would be made to feel the displeasure of his neighbors and would probably take heed and give attention to his own plant. If this did not work, then the Government could compel him to bring his plant up to a suitable degree of efficiency or limit his coal supply.

Mr. Podolsky in his discussion, made a suggestion along these general lines in which he suggested a national society for fuel saving. The local manufacturers' association to which I have alluded, could, if found desirable, be combined to form such a national society or association. This constitutes one of the most valuable suggestions that has been made in the discussion.

While our problem relates principally to fuel saving, labor saving is also important. Mr. Reinicker has brought out this feature in a limited way in his suggestion regarding an ashpit to hold 24 hours' accumulation. Of course this phase of the subject could be developed indefinitely, but this is aside from the present object. Mr. Reinicker, however, is wrong in his statement that "the results are probably 85 per cent due to design and 15 per cent to operation." As I demonstrated in the first part of my discussion, the combined efficiency is equal to the efficiency of the equipment multiplied by the efficiency of operation, and in my own practice I have found that in most factory plants a saving of 10 to 25 per cent can be made by modification of operating methods alone. I can quote cases where improvement has been as high as 50 per cent. Further savings, depending upon the original design of the plant, can be made by suitable changes in the equipment.

Mr. Beekley brings out the fact that there is a large saving to be made by the utilization of exhaust steam. This point was brought out in my paper in Par. 23. The actual saving, however, in case all the exhaust from an ordinary factory engine is utilized would approximate 90 per cent instead of the 30 per cent which Mr. Beekley quotes. (See my paper entitled The Heating Value of Exhaust Steam, presented at the annual meeting of the American Society of Heating and Ventilating Engineers in January 1915, in which I gave a formula for determining the heat value of exhaust steam from any engine, pump or turbine. In this paper are given curves from which the heat value of exhaust is determined graphically).

Mr. Trump's discussion is extremely valuable as he is bringing out the new idea in boiler-room management of giving the firemen an interest in the coal which they are able to save by intelligent effort. The statement which he has made should be convincing since it is based on actual experience in his own large plants. I have designed bonus systems for many plants

in this country. The reason that many bonus systems have failed is that they have not been suited to the particular case and local conditions for which they are supposed to be designed. But the bonus system will be increasingly used in this country during the coming years in connection with boiler-house accounting systems. Every plant in the country which burns as much as five tons of coal per day should have some kind of an accounting system to indicate at least approximately the efficiency of the boilers and furnaces. The best system is continuous weighing of coal and water by modern methods supplemented by flue-gas analysis. But where this complete system cannot be installed for practical reasons, a flue-gas-analysis system can be and should be installed. The United States Fuel Administration should endorse this specific measure in formulating a program to be sent out through the State Fuel Administrators to the industries.

Mr. Polakov speaks slightingly of what he is pleased to term "by correspondence-school methods." I did not suggest correspondence-school methods but I did suggest education by every possible means, both by personal teaching and by bulletins and circulars prepared specifically for definite purposes. Mr. Polakov's method is quite suitable for private consulting practice such as his or mine, and I follow his thorough methods in my own practice. But Mr. Polakov has evidently not considered the difference between a private practice and a national practice. For instance, were we to carry out Mr. Polakov's idea it would require four thousand Mr. Polakovs working eighteen months at a cost to the Government of $36,000,000 to make an inspection of three or four days in each industrial plant in the country. In the first place, we have not got four thousand Polakovs, neither can we wait eighteen months, and $36,000,000 is too much to pay for it. His plan is impracticable when it comes to a large-scale proposition.

What we require at the present time is a constructive policy and program which must be taken up by the United States Fuel Administration in a comprehensive manner. The plan must involve all the elements which I have suggested and there is no doubt but what such a plan will be formulated and adopted with large results. The 50,000,000 to 100,000,000 tons of coal a year can be saved and must be saved.

### Bagasse as a Source of Fuel, by E. C. Freeland

This paper was awarded Honorable Mention in the Student Prize Contest, 1917, and was included in the Power-Plant Session because of its connection with the fuel problem to which Mr. Myers's paper was devoted.

In it the author discussed the nature and value of bagasse as a fuel, and described methods for calculating its fuel value, methods used in drying and boiler furnaces for burning bagasse.

He said that the heating value of a pound of average dry Louisiana bagasse is found by experiment to be 8300 B.t.u., and despite a high moisture content of about 50 per cent it is therefore a valuable fuel. While in former years not much attention was paid to the drying of bagasse before burning it, many authorities now claim that a great saving can be effected by such procedure.

David Moffat Myers, in an extended written discussion, said that his most recent experience in connection with bagasse burning occurred during seven weeks in Cuba last winter, where he was retained to investigate and report upon the conditions of boiler-plant economy in six sugar mills. He submitted the following observations relating in particular to his investigation of a mill in the eastern part of the island, near Manzanillo Bay, with a capacity of 3750 tons per 24 hours.

In this section of the island the fiber content of the cane is only about 10 per cent, whereas in some other parts it runs as high as 12 per cent, thus giving in the latter a bagasse of greater heating value, while the mill requirements for steam are less owing to the lesser quantity of juice extracted. Consequently, the mill supplied with cane of the higher fiber content has a great advantage in respect to economy in the use of auxiliary fuel.

In Cuba, in a perfectly designed and properly balanced sugar mill, i.e., where the exhaust steam produced is no greater than the demand for it, and where all the condensation from modern multiple-effect evaporators is returned to the boilers, the by-product bagasse is sufficient to supply all the steam when all departments of the plant are working in harmony. But where these conditions do not obtain, and there are numerous examples, auxiliary fuel in the form of wood, oil or coal must be burned.

In Cuba, wood is the most common auxiliary fuel and the cheapest in cost per million B.t.u., although the connected labor is greater than with either of the other fuels.

There is no trouble whatever in obtaining a very high-grade combustion with bagasse, even with very crude methods and furnaces. When the supply of bagasse was coming regularly and no wood was used in the furnaces, the $CO_2$ ranged from 10 to over 17 per cent. When wood was fired in with the bagasse, especially by some of the methods commonly employed, the furnace efficiency was immediately reduced to a degree indicated by a $CO_2$ content of from 3 to 6 per cent.

By changing the method of firing the wood with certain furnace alterations, a great improvement was obtained both in more uniform steam pressure and in a substantial reduction of the amount of auxiliary fuel required.

From the standpoint of the mill owner the cost of the auxiliary wood fuel—formerly about $300 per day—was a matter of only secondary importance. But the difficulty in maintaining uniform working steam pressure was of vital importance, since the inability to do so was reducing the normal capacity of the mill by an amount of grinding equivalent to $500,000 per year in output of sugar.

Stated briefly, the causes for this loss due to inability to hold steam were as follows:

1 Irregularity in feeding the furnaces, due largely to ignorant labor without white-man supervision. Supervision was installed and a large improvement immediately effected.

2 Wrong method of firing wood with furnaces ill-adapted to the purpose. This was corrected and furnaces improved, with an additional improvement in steam pressure and substantial reduction in auxiliary fuel.

3 Draft regulation entirely wrong. Plan was prepared for convenient regulation by uptake dampers to control fires and steam production.

4 Grate surfaces with natural draft burned 300 lb. bagasse per sq. ft. per hour when clean after Sunday shutdown, but clinker on furnace walls grew so rapidly that by the middle of the week the grate area would become so restricted that the capacity of the boilers was seriously reduced and formed a chief factor in the inability to hold steam. This trouble was corrected in the new furnaces designed and installed by the writer by using larger grate surface. This resulted in ability to obtain boiler capacity at all times.

5 Owing to the surplus of exhaust steam in this badly balanced plant and to other causes relating to the design and

operation of the whole mill, sufficient condensation was not available for boiler feed. Consequently, raw water had to be used as a make-up supply. This water was from wells, and its analysis showed it to be of the most detrimental character for boiler feed that the writer had ever found. The boilers, as a consequenuce, were covered with heavy scale, pitted badly and were constantly springing leaks.

The effect on fuel economy and steam production need hardly be described.

The remedy recommended was a lime-soda process of purification, filtration and storage for the raw water, and this system has been specified, purchased, and will soon be installed.

Other changes were recommended and are being installed, and there is no doubt that when the improvements are all in effect the production saving of about half a million dollars per year will be accomplished.

In further regard to the combustion of bagasse, there is one point that is likely to be overlooked unless the combustion engineer is familiar with the operation of sugar mills. A bagasse-burning boiler plant is subject to a very critical disadvantage not imposed on any other kind of a boiler plant. There is no storage supply of fuel *at the furnaces* available for instant use when occasion demands. When the boiler pressure begins to drop rapidly, the natural method employed in coal-fired steam plants is to increase at once the feeding of the fuel and the supply of air to the furnaces. This method is not applicable with the usual design of sugar-mill boiler-house equipment. The bagasse carriers keep an approximately uniform stream of the fuel moving along over the furnace tops as the mills supply it, and it is fed directly from the carriers through adjustable gates and feeders to the furnaces. Any surplus bagasse travels to the end of the conveyor, where it discharges in a pile on the ground. This pile forms the only available storage of fuel.

Consequently, when a shortage occurs or when additional steam is quickly drawn from the boilers, there is no adequate method of meeting the emergency. The result is apt to be a serious drop in steam pressure, causing longer cut-off of mill engines and a further increase in the demand for steam. The excessive time required to pitch from the surplus pile into the conveyors, added to the time consumed by the travel of this bagasse to the furnaces, renders this method of storage of little or no avail. Therefore, unless auxiliary fuel, such as oil or coal, is immediately fired as the steam pressure begins to fall, the effect is so bad that at times it becomes necessary to shut down the mills to raise steam to working pressure.

This problem, it is believed, is more important than that of drying the bagasse, which must necessitate a complication of plant not desirable under the difficult conditions of ignorant labor which must be depended upon in Cuba.

In fact, the problem of bagasse burning cannot successfully be considered merely as a combustion problem, although, of course, that forms one of the factors. But other factors enter more importantly in an efficiently operated sugar mill. Some of these have been touched upon (in the beginning of this discussion), and they include considerations relating particularly to the scientific design of the whole mill combined with its operation.

If there is trouble and delay at the mills, the bagasse supply is interrupted and the best furnace design is of no avail; unless intelligent supervision of the regulation of bagasse feeding and of dampers and cleaning of fires is provided, scientific boiler and furnace equipment helps but little; if a shutdown occurs at the evaporators, the mills are badly affected.

The matter of boiler efficiency in a sugar mill is inflexibly connected to, and affected by, the operation of the production functions of the entire mill. Consequently, an efficient boiler plant becomes largely a by-product of these other conditions relating to the general management of the mill and the harmonizing and correlating of its functions.

Such very large savings can be accomplished along these lines, given a well-designed boiler plant, that such an apparatus as a bagasse dryer would not generally be favorably regarded by plant owners unless its installation and operation could be effected at low cost and its design were such as to require little or no attention and is virtually fireproof.

In the operation of the plant referred to, upon which Mr. Myers conducted a large number of tests on combustion and evaporation, when the $CO_2$ ran above 16 per cent there were usually found considerable amounts of CO. In one test for which a heat balance was computed, the CO produced a loss equal to about 12 per cent of the available heat in the bagasse as fired.

The corresponding flue-gas analysis was 14 per cent $CO_2$, 3.5 per cent $O_2$ and 3.7 per cent CO. This represented an average run of 3¼ hours.

The extent to which the $CO_2$ could be raised without formation of CO depended upon the furnace design, the larger combustion chambers making possible the higher values of $CO_2$ without loss due to CO. With some of the settings tested, 15 per cent $CO_2$ could be maintained with but an occasional trace of CO.

When bagasse is burned at high rates of combustion (200 to 300 lb. per sq. ft. of grate surface per hour), the time required for complete combustion is lengthened so that extra large combustion chambers must be employed if a high $CO_2$ without CO is to be obtained. Owing to the large volatile content of this fuel, the completion of combustion occurs at a point much later in its travel than in the case of coal under equally favorable conditions. Consequently, with horizontal tubular boilers, the combustion in many cases under forced conditions will not be completed until the gases enter the tubes at the rear end. A consequence of this is a comparatively high temperature of gases in the combustion chamber, thus rendering a large tube surface of especial value for absorbing as much as possible of the remaining heat.

The rapid filling up of combustion chambers by deposits of ash which fuse to hard clinker forms an added reason for providing very large combustion spaces in the design of furnace and setting. In the case of vertical-pass water-tube boilers, the boiler should be set sufficiently high and with such arrangement of arches and baffles as to complete the combustion before the gases enter the spaces between the tubes.

Following are a few brief notes relating to the available heating value of Cuban bagasse, weight of bagasse per boiler hp-hr., etc., selected by Mr. Myers from his report on the plant referred to:

FUEL VALUE OF BAGASSE AND BOILER HP. OBTAINABLE

| | |
|---|---|
| Assume mill to grind 300,000 arrobas[1] of cane per day with 75 per cent extraction, giving 75,000 arrobas of bagasse per day. Then, bagasse per hour = 3120 arrobas = 78,000 lb. = 39 tons of 2000 lb. | |
| Available heating value of bagasse calculated for this plant, B.t.u. per lb. as fired | 3,800 |
| B.t.u. per boiler hp-hr. (= 34½ × 970.4) | 33,479 |
| B.t.u. to generate 1 boiler hp-hr. at 60 per cent efficiency | 55,798 |
| Pounds of bagasse to generate 1 boiler hp-hr. = 55,798/3,800 | 14.7 |
| Bagasse available per hour when grinding 300,000 arrobas of cane per day, lb | 78,000 |
| Boiler hp. from bagasse when grinding 300,000 arrobas of cane per day = 78,000/14.7 | 5,310 |

[1] An arroba = 25 lb.

**Boiler hp. from bagasse when grinding 250,000 arrobas of cane per day** ..... **4,430**

**Boiler hp. from bagasse when grinding 200,000 arrobas of cane per day** ..... **3,533**

The heat value of the bagasse was computed in two ways, first by formula, and second by an assumption of dry heat value (which Mr. Myers confirmed by bomb-calorimeter tests) and calculating the heat-moisture loss. The results agree within 2 per cent. Both computations follow:

*Method 1.* Calculation from this mill's analysis of February 19, 1917, with B. & W. formula, assuming according to Noell Doerr that $G = S/10$. Formula:

$$\frac{8550F + 7119S + 6750G - 972W}{100} = \text{B.t.u. per lb.}$$

Percentage analysis from laboratory:

| | |
|---|---|
| $H_2O$ | 47.05 |
| Fiber | 44.55 |
| Sucrose | 6.81 |
| | 98.41 |
| Glucose (assumed $= S/10$) | 0.68 |
| Total | 99.09 |

Other gums and substances not shown by analysis.

$$\frac{381{,}000 + 48{,}400 + 4500 - 45700}{100} = 3882 \text{ B.t.u. per lb.}$$

*Method 2.* Assume 8300 B.t.u. per dry lb. ("Steam," Babcock & Wilcox Co.) and 47 per cent moisture. Then, total heat $= 0.47 \times 8300 = 4399$ B.t.u. per lb. as fired.

With flue temperature = 512 deg. fahr. and temperature of bagasse = 82 deg. fahr., heat to evaporate moisture =

$$0.47\,[(212 - 82) + 970 + 0.48(512 - 212)] = 585 \text{ B.t.u.}$$

| | |
|---|---|
| Total heat per lb. as fired | 4399 B.t.u. |
| Heat to evaporate moisture | 585 B.t.u. |
| Available heat per lb. as fired | 3814 B.t.u. |

This checks to within 2 per cent of the value obtained by Method 1.

Available heat per lb. of combustible =

$$\frac{3814}{100 - (0.47 + 0.01)} = 7340 \text{ B.t.u.}$$

(Ash assumed at 2 per cent.)

H. L. Hutson wrote that the author's paper starts a train of thought which it is interesting to follow, namely: "What will our descendants do when the supply of stored sunshine in the shape of coal and oil is exhausted and they have to grow their own fuel from year to year?"

Taking Mr. Freeland's figures and assuming for Louisiana an average crop of 20 tons of cane per acre, we find that this would yield five tons of bagasse, which would have a fuel value equal to about one ton of coal. By a little figuring it can be shown that we can grow this fuel at about eight times the cost of coal.

Our descendants will, no doubt, use their fuel more economically than we do and may, in many cases, get more than eight times as much useful work out of it. In fact, in China, the ratio is no doubt larger than this, as they will cook their food in an oven heated by a bundle of stems of cotton or other crop, and then sleep on top of the oven by night and use it as a seat by day.

In parts of the tropics, alcohol made from molasses is cheaper than gasoline, and the efficiency of this fuel used in an internal-combustion engine is several times better than that of a steam engine using ordinary fuel.

## The Cooling of Water for Power-Plant Purposes, by C. C. Thomas

This paper presents the results of an extended experimental investigation into the conditions governing the cooling of the condensing water of power plants by means of spray ponds. This investigation involved determining the efficiency of the cooling process under varying conditions of pressure at the spray nozzles, the temperature of the water to be cooled, the power required to circulate the water, the height of sprays above the pond surface, the effect of wind velocity on the cooling range, etc., and the work resulted in a large collection of data, much of which is presented in the text.

As a result of his experiments the author developed a new form of spray head or nozzle which is so adjustable that the film of water discharged may be broken into either a uniformly fine spray, or mist, or a large number of small drops, as desired. This method of spraying is particularly applicable to low-pressure work, a pressure of 10 in. of mercury giving an exceedingly fine spray, and 8 in. usually sufficing.

Probably the most completely controlled means for cooling water in large quantities is found in the forced-draft cooling tower. The newly developed spray head, however, provides for control of the system in a manner which, while somewhat less complete than in the case of the cooling tower, yields results comparing very favorably with those for the tower, and can be installed and operated at a much lower cost.

B. R. T. Collins, referring to efficiencies with water falling on the bare cement bottom of pond as compared with those when the pond contains its normal amount of water, wrote that the author's curves show 10 to 15 per cent higher efficiency with a full pond, thus controverting his statement in regard to the advisability of constructing a pond with practically no water in it. He believed the result shown by the curves indicates that a bare pond absorbs heat from the surroundings more readily and conducts this heat to the water sprayed upon it, thus raising the temperature of the water and reducing the efficiency. Hence, a certain depth of water should be carried in the pond to prevent this, 2 or 3 ft. being the best depth when everything is taken into consideration.

The author stated that the loss from cooling ponds with non-adjustable nozzles, in windy weather, is as high as 10 or 15 per cent. His experience is summed up by a typical case of a test made on a pond with non-adjustable nozzles at Hutchinson, West Virginia. An accurate record of all make-up water delivered to the pond during the month of August was kept, and this showed a total loss due to evaporation, drift and leakage, of 1.33 per cent of the water sprayed. The capacity of this pond was 3000 gal. per min.

There is one disadvantage in using adjustable nozzles such as the author describes when installed over a natural pond. The water in these ponds generally contains a certain amount of vegetable growth. This tends to clog the spiral slot, resulting in reducing the capacity of the nozzle appreciably, and increasing the size of the drops to a very considerable extent. This occurs in the course of a short period of time, about 10 to 15 min. after starting with a clean nozzle. This, of course, is an inherent difficulty with all nozzles of this type. It is fair to assume that an artificial pond or basin would become foul in the course of time, and cause the same difficulty.

The results reported in the paper bear out his experience in that the highest efficiency of a spray-cooling system is obtained in hot, humid weather, and the lowest efficiency in cool, dry weather. This is an advantage which a spray system has over cooling towers, as his experience has shown that hot, humid weather reduces the efficiency of towers to a very considerable extent. This, he believed, is due to the fact that the air is in contact with the water a much shorter length of time with a spray system than it is with a cooling tower of standard manufacture.

Edwin Burhorn contributed the following written discussion of the paper, the title of which he thought somewhat misleading, as it was entirely too broad, the subject-matter being devoted to cooling water by means of spray nozzles, particularly to a form of spray nozzle devised by the author:

Spray nozzles are used for cooling water for power-plant purposes but can also be used for cooling water for any purpose. Furthermore, there are many other methods of cooling water than those mentioned by the author and these different methods should have been covered by the author in order to fully justify the selection of the broad title of the paper.

The paper is interesting as far as it goes, but is not conclusive and leaves much to be desired. It is in line, however, with most of the papers that have been submitted from time to time covering various methods of cooling water, these limiting themselves to a particular apparatus. Attempts have been made to devise some general formula that could be used in connection with cooling towers, but on account of the many variables in connection with such work, the subject was given up. The process of cooling water is of such consequence and so vitally affects the efficiency of many operations that it is highly desirable that some reliable investigation be made regarding the relative value of the different methods available.

Among these methods are the plain cooling pond, spray nozzles alone or in connection with cooling ponds, cooling towers operated by means of air forced in by fans, or cooling towers in which the air is exhausted, cooling towers operating under the action of natural draft created by a stack, and cooling towers of the so-called "atmospheric" type, which operate through the action of natural air currents.

It should be borne in mind that all cooling systems are dependent on atmospheric conditions and vary with varying atmospheric conditions, and the maximum point of cooling is that of the temperature of the wet-bulb thermometer and not the temperature of the dewpoint. If the cooling system were so designed, with proper cooling surface, etc., it could reach the temperature of the wet bulb under all atmospheric conditions. From a practical standpoint, however, it is not advisable to so design such apparatus, as the great cost would not be justified by the additional reduction in temperature.

A comparison of the various cooling systems should include not only the cooling apparatus itself but also the auxiliary apparatus such as pumps for pumping the water and fans, if any, for creating an artificial circulation of air. In other words, the cost of operating various systems per annum should be investigated so that reliable data could be obtained. The interest on the investment and depreciation should also be taken into consideration and an investigation of this character would undoubtedly be of exceedingly great value. It would involve, however, considerable labor and expense.

Referring to the paper,[1] it will be noted that the curves in Figs. 7 and 8, showing the variation of efficiency of the adjustable spray head, were obtained by adjusting the spray head to suit the weather conditions existing at the time. It would be interesting to know how such adjustment is made and on what basis, as the weather conditions change from day to day and very abruptly even in a single day. It seems somewhat impractical to adjust these nozzles to suit all weather conditions. In a large installation, also, it would seem impossible to make this adjustment without shutting down the water supply or constructing a series of tunnels underneath the collecting basin to give accessibility to the adjusting rods. It is also somewhat difficult to tell whether the nozzle is adjusted for the most efficient conditions without carrying on a continuous series of tests unless the object were to attain a temperature of the wet-bulb thermometer, and of course in that case the nozzle would be adjusted until that temperature was obtained. The results of tests, however, seem to indicate that the reduction of temperature is, under most conditions, over 10 deg. above the temperature of the wet-bulb thermometer.

The curves in Fig. 10 are intended to show the wide variation of efficiency when proper adjustment of spray head is neglected. It is therefore of considerable interest to know how the spray heads can be kept properly adjusted to suit the ever-changing atmospheric conditions. The black circles refer to non-adjustable nozzles and the other circles to adjustable nozzles operating "without any attempt to obtain high efficiency." There does not seem to be much choice between the two types of nozzles and it would have been interesting to have seen the results for a period of one year where the adjustable nozzles had been operated with an attempt to obtain high efficiency.

In reference to Fig. 12, in which the efficiency is lower with a bare pond than with a full pond, Professor Thomas seems to be surprised at the results. This should not be at all surprising, as it is what would naturally be expected. The full pond offers considerable evaporating surface in addition to the surface exposed by the spray, and, furthermore, the evaporating surface is near the ground level where it can take advantage of prevailing air currents. On the other hand, the bare pond most likely did not offer the same amount of cooling surface as the full pond, and, furthermore, what cooling surface there was, was quite some distance below the ground level. This would therefore make it less accessible to air currents and naturally there would be less evaporation with the bare pond. The same reasoning may explain why the spraying on superposed inclined cement plates showed a falling off of efficiency owing to the fact that the cement plates may have offered obstruction to the prevailing wind currents and also reduced the cooling surface by collecting the spray into larger drops. No details showing the inclined cement plates were given and therefore a definite conclusion on this point cannot be reached.

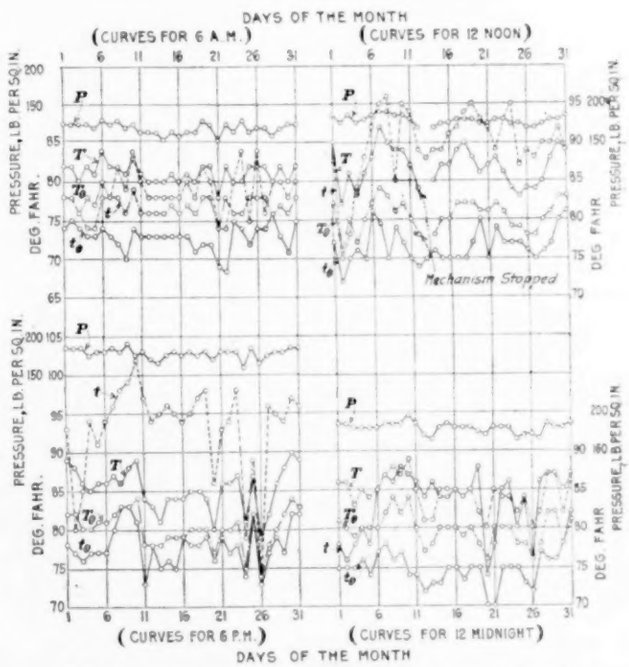



FIG. 1 CURVES SHOWING HIGH EFFICIENCIES WITH ATMOSPHERIC TOWERS

The effect of wind velocity on cooling range is indicated in Fig. 14, but not very much is said on this subject. This,

[1] The figure numbers given here are those in the complete paper as published in pamphlet form.

however, is a very important matter in obtaining satisfactory results. As the cooling of the water is done partly by convection and partly by evaporation, it is absolutely necessary in order that this process may continue that the air be in motion. Where the humidity is 100 per cent, all cooling is practically by convection, and the amount of cooling is limited entirely by the amount of air that passes over the water to be cooled. It can be readily seen, therefore, that under certain conditions a higher wind velocity will give very much better results. It is seldom, however, that the air is absolutely quiescent, there being at all times some wind movement; but even where there is no wind movement, the action of the heated water on the air would tend to create upward air currents and thus facilitate the action of the cooling. Were this not so, there would be absolutely no cooling possible unless there were wind movement. The efficiency of the cooling apparatus is based not alone on the range of cooling but also on the loss of water from all causes. Professor Thomas reports on the loss "due to evaporation." There is, however, an additional loss due to windage and this must be carefully known, as the total loss is what must be made up, and, if purchased, will represent an item of expense that should be taken into consideration. The loss from windage will depend on the velocity of the wind and also the size of the pond, and the size of the pond should be dependent on the maximum pressure of discharge at the nozzle.

The Johns Hopkins pond has an area of 962 sq. ft. and the amount of water handled varied from 20 gal. to 300 gal. per min., as indicated in Fig. 8. In the first case the area was about 48 sq. ft. per gal. per min., whereas in the second case the area was about 3.2 sq. ft. per gal. The loss of water due to windage would of course vary considerably, particularly with the average wind, but apparently no data are given on this important subject.

The loss due to evaporation would depend on atmospheric conditions and where all the cooling is done by evaporation the loss would be about 1 per cent every 10 deg. the water is cooled. It should be noted that Professor Thomas states the loss from non-adjustable nozzles in windy weather is as high as 10 to 15 per cent, but he does not show how with an adjustable nozzle the loss can be reduced by merely adjusting the nozzle. The windage loss might be greater with an adjusting nozzle owing to the fine spray, whereas the loss due to evaporation should be the same regardless of the nozzle, provided the cooling results are the same.

There seems to be some mistake in regard to the loss due to evaporation at the pond at Sparrows Point, Md., given by Professor Thomas as 0.31 per cent. At this pond, apparently, the water was reduced in temperature from 178 deg. fahr. to 125 deg. fahr., or a reduction of 53 deg. Unless the test was made in winter where there was no evaporation, or very little, then undoubtedly the loss should have been much higher; and particularly in the summer where the air temperature is high, the greater part of the cooling will be done by evaporation and in this case, if all the cooling were done by evaporation, the loss would have been, theoretically, 5.3 per cent.

Professor Thomas also endeavors to prove the advantage of the adjustable spray nozzle over the ordinary type of spray nozzle and states that the adjustable nozzle permits "regulation of the spray to suit weather conditions and to minimize loss of water and inconvenience to the nearby buildings due to driftage in windy weather." This is an admission of the inefficiency of the spray nozzle in general and a claim for an improvement due to the adjustable type of nozzle, but no proof is offered to justify the conclusion.

The curves in Fig. 8 show a variation of efficiency of the adjustable spray head with variation of capacity, but a close examination of the three curves shows them to be very nearly identical, the variation being only slight and hardly any advantage on this account.

Professor Thomas also states that "it has been somewhat surprising to find that very good cooling effect frequently obtains in very humid and even in rainy weather." He does not refer to any particular tests that have caused the surprise, but bearing in mind that it is possible to cool the water to the temperature of the wet-bulb thermometer, nothing would be surprising unless the temperature were reduced below that of the wet-bulb thermometer.

The results of cooling with spray nozzles were also compared with a few selected tests of one type of cooling tower, but as this cooling tower was not necessarily the most efficient obtainable, the comparison is not a fair one. The details of construction of the cooling towers were not given and the amount of water circulated in the cooling tower at the time the tests were made may not have been the full capacity of the tower. The data given were not sufficient to make these tests of any value for comparison. If, however, the cooling towers were all operated under their figured capacity, they show a variation *in efficiency* that seems to indicate improper design in some cases.

In Table 2, test No. 4 shows an efficiency of 0.928, whereas test No. 5 shows an efficiency of 0.391. If Professor Thomas would compare the results of his spray nozzles with the results that have been obtained with atmospheric-type cooling towers, in which the water has been reduced to within 1 to 5 deg. of the temperature of the wet-bulb thermometer, varying with the atmospheric conditions, he would then find that his results do not compare very favorably with those of that type of cooling tower.

Attention is also called to Table 8, showing tests of nozzles with spiral cores, and it is noted that on the test of nozzles consisting of two 1-in. sprays, high efficiencies are shown, namely, 0.798 in one case and 0.883 in the other. Table 7, of tests of the Thomas spray head with and without screen, does not show any test where the efficiency equals these, the highest shown being 0.75, in test No. 106, using the Thomas head with wire screen.

The spray-nozzle system undoubtedly has a field of usefulness but it is not adapted for cooling water where high efficiency is necessary or advantageous, such as in refrigerating and ice-making apparatus and steam turbines. In these plants the lower the temperature of the water used for cooling, the higher the efficiency of the apparatus, and cooling towers of the atmospheric type are able to cool the water to within 5 deg. of the temperature of the wet-bulb thermometer, whereas with the spray nozzles it is shown to be practically impossible to reach closer than 10 to 15 deg. of the wet-bulb temperature. In certain uses where high efficiency is not necessary, or for temporary service only, the spray nozzle is well adapted.

In order to show the high efficiencies actually obtained in practice with towers of the atmospheric type, the chart shown in Fig. 1 is submitted. This chart shows by curves the daily temperatures, during the month of July, the readings being taken each day of the month at 6 p.m., noon, 6 a.m. and midnight. These tests were taken from a tower in regular operation at Dallas, Texas.

Attention is called to the generally close shape of the curves of the temperature ($T_o$) of the water leaving the tower and the temperature ($t_o$) of the wet-bulb thermometer, and

particularly it should be noted that in several cases the temperatures were identical and the maximum variation about 5 deg. The wind velocity of course varied, and it should be noted that very little advantage could have been obtained in any of these tests had the wind velocity been higher than it really was.

This fact proves merely that the tower was properly designed and of sufficient surface in order to cool the water within 5 deg. of the wet-bulb thermometer under practically the worst possible atmospheric conditions. Furthermore, under the best atmospheric conditions the water was reduced to the temperature of the wet-bulb thermometer.

A. G. Christie, who presented the paper in the absence of the author, said in reply to Mr. Collins that they had found the bare pond not so efficient as the pond with a considerable amount of water. On the other hand, a full pond was not desirable in the North. There was a mean in the depth of pond which gave general efficiency—in their own particular pond about 18 to 20 in. instead of 3 ft.

### THE STEAM MOTOR IN THE AUTOMOTIVE FIELD, BY E. T. ADAMS

In this paper the author stated that the tremendous increase in the demand for automotive power has outdistanced the ability of the gasoline engine to meet this demand, chiefly on account of the condition that the supply of fuel is not now equal to the requirements.

The steam unit has many advantages for automotive service. Its high torque at low speed, its overload capacity, its smooth, flexible speed and power control have remained the standards of excellence, reached for but never attained by any gasoline motor.

The design of the steam unit is simple and many features of construction have been introduced which tend toward long life and low cost of upkeep.

Numbers of new steam trucks, tractors and pleasure cars are in service, or in process of manufacture or design. This effect and this demand will have a profound influence on the automotive industry.

John Younger, in a written discussion, entered a defense of the gasoline-propelled vehicle. He wrote that there has been a marked trend in design to improve carburetors to a point where kerosene can be used, and this, of course, to a certain extent, if successful, will practically double the quantity of gasoline available. There are today many internal-combustion engines running reasonably satisfactorily on kerosene, and the next year or two should see tremendous strides in the use of this or even slightly heavier fuels.

The author's statement that "the chief force which is bringing about the increased use of the steam motor is its superior fitness for automotive service, especially in the commercial field," is somewhat doubtful when the situation is studied at large. So far as he could see, there is no great demand, or any demand to speak of, for a steam automotive vehicle, for the simple reason that they were tried out as recently as ten years ago and practically abandoned. If you turn to the situation in England, where steam vehicles using coal, coke and gasoline have been used for some fifty years, you will find that the gasoline truck and the kerosene truck have supplanted the steam vehicle almost entirely. The same condition is found in the agricultural-tractor industry at the present moment, where the steam vehicle, which has so long been used by the farmer, is being actually forced out by the internal-combustion engine.

The upkeep of the gasoline truck, even with inexpert service, is not a serious handicap to the business. The cost of repairs on the gasoline motor truck is surprisingly low. Repairs lower than two cents per mile are very commonly met with.

The seeming simplification of the steam vehicle is so purely on the chassis. The engine, as Mr. Adams stated, is very similar to the gasoline engine. The rear axle, the front axle, the frames, the springs, the driver's seat, the radiator, or rather the condenser, are all duplicated in the gasoline-driven truck. This leaves practically the transmission and clutch, and this mechanical device, which usually gives absolutely no trouble, is replaced by a high-pressure steam boiler with its elaborate piping and connections and firing; so far this has not been worked out satisfactorily.

Before becoming too enthusiastic on the advantages of the steam motor in the automotive field, the whole history of the subject should be studied without any bias, and present-day installations of trucks of all kinds, not only in this country, but abroad, should also be studied very closely, and the repairs, etc., analyzed.

The author takes the very broad standpoint that whether steam will actually supplant gasoline or not is of minor import. It is quite possible that there can be a field for the two types, side by side, and anything that will help conserve our fuel supply must be worth while.

Wm. Clinton Brown[1] contributed a written discussion upholding the use of steam tractors. He said it was possible to produce a steam tractor having a total weight, including fuel, water and operator, around 125 lb. per b.hp. This is a machine lighter and far more compact than the majority of gasoline tractors. It is even only about one-quarter of the weight and less than half the size of the standard type of steam tractor of the same power.

John Sturgess presented a written discussion, which merits publication in full later, endorsing in general the author's conclusions, which he considered self-evident, but criticizing some of his references to details of construction.

He wrote that although the author referred to the extreme simplicity of the connection between motor and axle, the simplicity of the entire power plant merited equal emphasis. The modern automobile type of steam engine has but fifteen moving parts, compared to some hundreds in the internal explosive engine and its transmission.

The author stated that modern steam cars are of the multi-cylinder type. He had no knowledge of any steam car using or proposing more than two cylinders, for nothing would be gained thereby.

The author further stated that the uniflow type of engine is largely used, giving as the reason its simplicity and economy when operated non-condensing. He knew of only one advocate of the uniflow engine for automobile use, and he did not believe any claim was made by that advocate that cars have really been placed in the market as yet. In practice this design does not prove any simpler than, if as simple as, the contra-flow, while in its application to automobile needs grave difficulties are encountered which do not occur in stationary practice.

He could not agree with the author's summary of boiler practice. As yet the water-tube type has not proven its commercial success, never yet having been marketed. The flash type is practically abandoned, owing to its several difficulties, including those of temperature and pressure control. On the other hand there are some thousands of cylindrical fire-tube boilers in daily use under every kind of service, in many cases

[1] Syracuse, N. Y.

the boilers being eight to ten years old. Among these, to his knowledge, there has not been one single case of destructive explosion due to construction methods.

He contested the author's statement that in spite of its high economy and honorable record in service, the system of converting oil under pressure into a vapor, and burning with a Bunsen type of burner, with pilot light for starting, is steadily being displaced by more modern design. His statement implies that there is a different practice already in vogue, which he doubted. Recent proposals have been made, but these could hardly be dignified by the title "modern designs."

Summarizing our present-day knowledge, as a basis for continued development, the author alluded to the clear-cut demands of the public growing from extended past experience with both steam and gasoline. Notwithstanding the efforts made, almost single-handed, against a deluge of fashion, to popularize the steam car, the writer thought the public generally is as yet uninformed as to steam-car performance.

J. D. Nies[1] and Allen C. Staley also contributed somewhat extensive written discussions in full agreement with the main argument of the paper, and emphasizing the leading features which the author brought out but differing with him in details.

Mr. Staley's discussion took up particularly the type of boiler of the steam automobile, and gave the arguments for and against the fire-tube and water-tube types respectively.

Mr. Nies considered one by one the desirable features of an automobile power plant, as enumerated in the advertisements of gasoline cars. These features are smoothness, flexibility, great reserve power, hill-climbing ability, acceleration, absence of gear shifting and low cost of operation. He then demonstrated how the steam motor compared with the gasoline motor in all these features.

Edwin N. Trump emphasized the advantages of using a uniflow engine in the steam automobile. This engine gave a very flat economy curve, but the very high initial pressure gave such a high initial torque, at least double the ordinary running torque, that it was possible to start a uniflow-engine steam truck under conditions under which it would be impossible to start a gasoline truck.

Many people are interested in the steam truck because they feel that it will give them an ability to start a load and keep the truck going under conditions absolutely impossible with the gasoline engine.

The author, in closing, thanked the discussers for the courtesy of their retorts.

He said that it was really a romance of engineering that this development had, perhaps, first taken place in the field of the pleasure car, whereas sound business sense and engineering ability indicated that it is in the field of trucking and similar work that the steam unit has its best place.

He felt we were now at the start of what would become a tremendous industry, vital to the best interests of the country and of very great importance in the field of farming and trucking.

He had not desired to raise questions as to whether this design or that design were better, but merely to call attention to a new engineering problem which is before us in its infancy and which must be shaped and formed according to what is best for the country as a whole.

[1] Lewis Institute, Chicago.

# DISCUSSIONS OF PAPERS ON VARIED SUBJECTS

## Opinions Expressed at the First General Session of the Annual Meeting, when Papers on Heat Transfer, Surface Resistance, Air Purification, Balancing, etc., Were Presented and Discussed

THE first General Session was called to order at 2:30 p. m. by Prof. Charles R. Richards, who acted as chairman. Six papers were presented at this session—the last two by title—as follows:

THE TRANSFER OF HEAT BETWEEN A FLOWING GAS AND A CONTAINING FLUE, Lawford H. Fry.

A STUDY OF SURFACE RESISTANCE WITH GLASS AS THE TRANSMISSION MEDIUM, H. R. Hammond and C. W. Holmberg. Awarded Student Prize, 1917.

APPARATUS FOR COOLING, DRYING AND PURIFYING AIR, W. J. Baldwin.

RECENT DEVELOPMENTS IN BALANCING APPARATUS, N. W. Akimoff.

PLOTTING BLOWER-TEST CURVES, A. H. Anderson.

CROSS-CURRENT PREDETERMINATIONS FROM CRANK-EFFORT DIAGRAMS, Louis Illmer.

### MR. FRY DISCUSSES HEAT TRANSFER

The first paper to be presented was one by Lawford H. Fry, in which he developed a logarithmic formula covering the important thermodynamic process of the transfer of heat between a flowing gas and the wall of the containing flue, which formula, within the range of experimental data available, has been found to give satisfactory results.

E. A. Fessenden submitted a written discussion, in which he said that Mr. Fry's paper is a distinct contribution to the study of the transmission of heat by convection. While much excellent experimental work has been done, apparently no one has heretofore succeeded in correlating and harmonizing the results of many investigators so satisfactorily as is done in this paper. Formulæ showing the relations between factors involved in heat transmission by convection have been proposed in so many different forms that it has been difficult to realize that any connection exists between them. Instead of using these formulæ, proposed by various experimenters, Mr. Fry has gone to the original data and demonstrated that all the results may be satisfactorily represented by a single equation. The data are thus no longer more or less chaotic, but consistent, not only for each separate series of experiments, but for all. That this is true for data gathered under a wide variety of conditions encourages the belief that the real solution of the problem is brought nearer.

The general formula, Eq. [1], proposed at the New Orleans meeting in 1916,[1] was based upon two series of experiments and confirmed by several other isolated sets of data. No attempt was made at that time to evaluate the constant $M$. A little later, a full account of these experiments was published,[2]

and an empirical equation was given which satisfied these particular tests, namely,

$$M = 0.195U^{-0.435}$$

where $U$ is the weight of gases per hour per tube multiplied by the hydraulic depth in inches. The experiments did not cover a sufficiently wide range of conditions to warrant proposing this as a general formula.

Fig. 1 shows several sets of experimental data plotted upon log $M$ and log $U$ as coördinates. Since $U = Wr$ and $\log U = \log W + \log r$, this method of plotting differs from that used by Mr. Fry only in shifting points horizontally by an amount depending upon $r$. The amount of displacement is constant throughout any single series, so that the slope of the lines connecting the points is unchanged. The data plotted include all those used by Mr. Fry, and in addition the following:

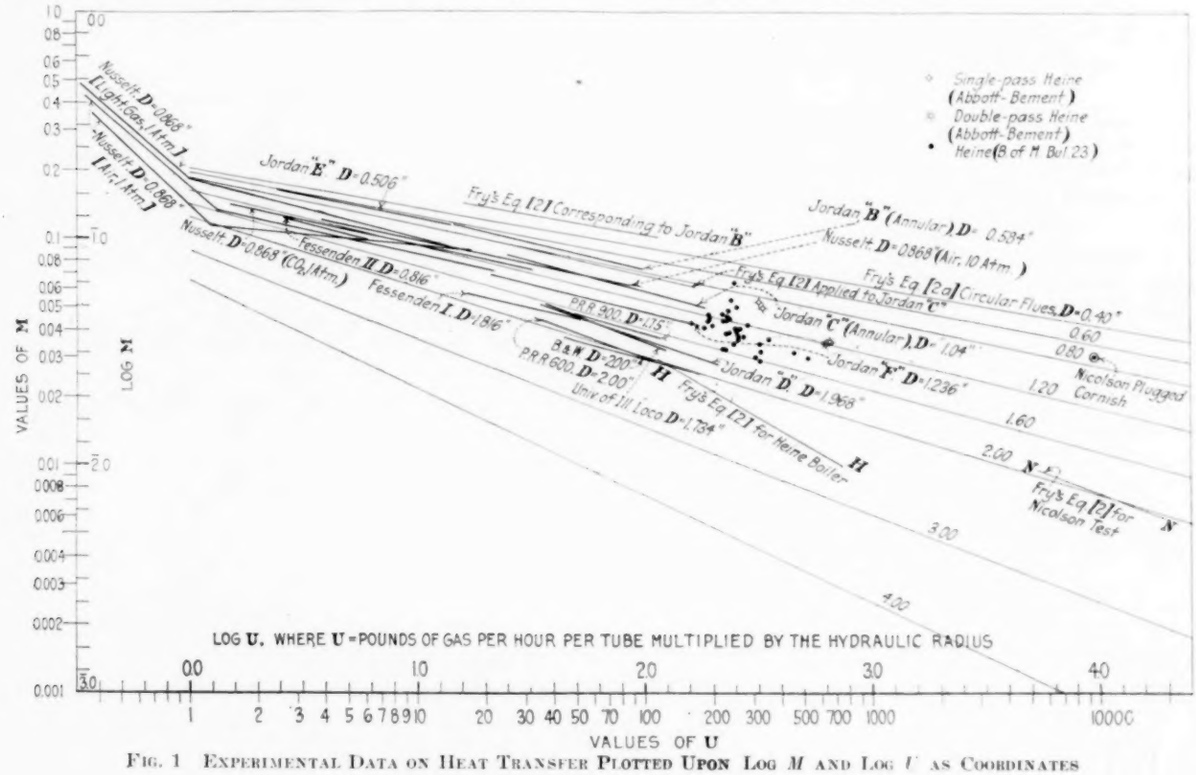

Single-pass Heine (Abbott-Bement)
Double-pass Heine (Abbott-Bement)
Heine (B. of M. Bul. 23)
Nusselt D=0.868" (Light Gas, 1 Atm.)
Nusselt D=0.868" (Air, 1 Atm.)
Jordan "E" D=0.506"
Fry's Eq. [2] Corresponding to Jordan "B"
Jordan "B" (Annular) D=0.584"
Nusselt D=0.868" (Air, 10 Atm.)
Fry's Eq. [2a] Circular Flues, D=0.40"
Fry's Eq. [2] Applied to Jordan "C"
Jordan "C" (Annular) D=1.04"
Jordan "F" D=1.236"
Jordan "D" D=1.968"
Nicolson Plugged Cornish
Fry's Eq. [2] for Nicolson Test
Nusselt D=0.868" (CO2, 1 Atm.)
Fessenden II D=0.846"
Fessenden I. D=1.846"
P.R.R. 900 D=1.25"
B. & W. D=2.00"
P.R.R. 600 D=2.00"
Univ. of Ill. Loco D=1.734"
Fry's Eq. [2] for Heine Boiler
VALUES OF M
LOG M
LOG U, WHERE U = POUNDS OF GAS PER HOUR PER TUBE MULTIPLIED BY THE HYDRAULIC RADIUS
VALUES OF U

FIG. 1 EXPERIMENTAL DATA ON HEAT TRANSFER PLOTTED UPON LOG $M$ AND LOG $U$ AS COORDINATES

1 A series of tests made upon a consolidation locomotive.[1]

2 Some tests made by the United States Bureau of Mines upon a Heine boiler.[4]

3 Some tests made upon single- and double-pass Heine boilers by Abbott and Bement.[5]

4 Nicolson's tests upon a Cornish boiler, in which a firebrick plug was inserted in the flue, leaving an annular gas passage 1½ in. wide.[6]

In order to reduce confusion, the separate experimental points for the tests used by Mr. Fry and for the additional locomotive series are not shown, but the heavy lines in the figure represent quite accurately the tests indicated. The light lines are plotted from the author's equation [2*a*] for flues of circular cross-section. The other three groups of tests did not cover a sufficiently wide range of conditions to permit curves to be drawn to represent them, but they do indicate that the author's Equation [2] for $M$ in its present form does not apply universally. It should be emphasized, however, that these latter data are very much beyond the range of those investigated by the author of the paper. In the Heine boiler the gas passage through the prism occupied by the tubes is not of circular cross-section, but is the space left around 3½-in. tubes on 7-in. centers, staggered. The hydraulic mean depth of the gas passage is about 1.31 in., and for a single tube the perimeter is 10.996 in. In order to conform to the author's Equation [2], the points[7] for tests on the Heine boiler should cluster around the line marked *H-H*. Instead, the actual points indicate values of $M$ about 2¼ times as large as are given by the proposed equation. A similar discrepancy is indicated for the Nicolson experiments.

A somewhat similar discrepancy may be shown for tubes of circular cross-section larger than those covered by the experimental data. For example, in an ordinary return tubular boiler with 4-in. tubes, 16 ft. long, operating with 65 per cent overall efficiency and at rated load, with 18 lb. of air per pound of coal, an average of about 135 lb. of gases pass through each tube in an hour. The hydraulic depth is 0.933 in., and by the author's Equation [2] the value of $M$ is 0.00912. If the water temperature is 366 deg. fahr. (corresponding to 150 lb. gage pressure) and the flue-gas temperature 600 deg. fahr., the temperature of the gases entering the tubes by Equation [1] is only 730 deg. fahr. Under the operating conditions assumed above, we might reasonably expect a furnace temperature of 2000 deg. fahr. to 2200 deg. fahr. The tempera-

[1] Trans. Am. Soc. M. E., vol. 38, p. 407.

[2] University of Missouri Bulletin, vol. 17, no. 26 (Oct. 1916).

[3] University of Illinois Engineering Experiment Station Bulletin, no. 82.

[4] United States Bureau of Mines, Bulletin 23. (Boiler no. 1).

[5] United States Bureau of Mines, Bulletin 18, p. 155.

[6] *Power*, Feb. 7, 1911, p. 222.

[7] The boiler used in the Bureau of Mines tests had tiles completely encircling the lower row of tubes, forming a tile roof to the furnace. In computing $M$ the furnace temperature was taken as the temperature at the entrance to the tube bank, and for the end of the tube bank the temperature was taken as that of the flue gases. Thus the assumed temperature drop through the tube bank is undoubtedly too high, with a corresponding error in $M$. This does not account for the large departure in the values of $M$ from Mr. Fry's curve, since their allowances for the errors in the assumed temperature drop would reduce the values of $M$ possibly 20 to 30 per cent.

ture drop from furnace to tube entrance would then be about 1300 deg. fahr. to 1500 deg. fahr., i.e., about 91 per cent of the total heat absorbed by the boiler is taken up by the shell by radiation from the firebox and by convection in the combustion chamber, leaving only about 9 per cent for absorption by the tubes. This is decidedly inconsistent with our usual ideas as to the value of the tube surface. If the temperature at entrance to the tubes is assumed to be, say, 1700 deg. fahr., the value of $M$ is 0.0325. Rather curiously, considering its limited basis, the value of $M$ for the same conditions computed from the formula $M = 0.195U^{-0.415}$, mentioned above, is 0.0284. In the footnote on page 18 of the paper, it is stated that Eqs. [2] and [2a] are both applicable to flues of circular cross-section. They do not give exactly consistent results, however. For example, for the case of the return tubular boiler just considered, Eq. [2] gives $M = 0.00912$, while Eq. [2a] gives $M = 0.00812$.

Within the limits of the experimental data investigated, the author has apparently succeeded admirably in adapting the basic formula to widely varying conditions. Beyond these limits, i.e., for tubes larger than 2 in. in diameter and for passages of irregular cross-section, more experimental work is necessary before any very definite extension of the author's formula can be obtained. The Heine boiler tests and the Nicolson test, shown in Fig. 1, suggest that Mr. Fry's straight lines may be tangents to rather flat curves. Inspection of the author's Fig. 13 suggests that possibly the values of $B$ and $m$, instead of being represented by straight lines, may lie on curves of parabolic form. This would increase $B$ and decrease $m$ for passages of larger "effective diameter" and thus increase $M$.

E. R. Hedrick wrote that there were reasonable grounds for supposing that there is really a break in the behavior when $W$ had what was called by the author the critical value of (about) 5 lb. per hour. Also it was possible that a different relation for the effect of the flue diameter will have to be worked out when experiments were available in which a greater variety of values of $d$ occurred. Possibly the relations suggested by Fessenden and Haney (Univ. of Mo. Bulletin, vol. 17, no. 26) might be found at least helpful in settling this question.

The author referred early in the paper to the fact that "no attempt is made to measure the rate of heat transfer." However, it should be emphasized that any formula that gave the temperature (or the heat-content) of the gas in terms of the distance along the tube, implied directly a law for the rate of heat transfer. This was the reason that the Osborne-Reynolds hypothesis led to a definite law for the drop in temperature along the tube, which enabled us to compare it directly with such experiments as those of this paper. It was shown in the paper by Professor Fessenden and himself (Trans. A.S.M.E., vol. 38, p. 407) that their formula [18], which is identical in meaning with formula [1] of Mr. Fry's paper, led directly to the formulæ [24] and [25] of their paper:

$$d\theta/dx = -m\theta \log_e(\theta/\theta_w)$$

or

$$d\theta/dx = -2.3026\, mR_0\theta_e^{-mx}$$

where the notation is that of their paper. From these, it was but a step to show that the rate of heat transfer (per degree difference in temperature per square foot of heating surface per second) was expressible by the formula

$$\frac{C_p w}{\pi d} \cdot \frac{1}{\theta - \theta_w} \cdot \frac{d\theta}{dx}$$

where $w$ is the weight of gas passing per second, $C_p$ the specific heat of the gas, and $d$ the diameter of the tube. Hence, the rate of heat transfer was proportional to

$$\frac{C_p\theta}{\theta - \theta_w} \log\left(\frac{\theta}{\theta_w}\right)$$

In any event, the rate of heat transfer was certainly not proportional (simply) to the difference in temperature, as was abundantly shown by the experiments quoted in this paper.

J. F. Barkley[1] wrote that, after an extended experimental study along the lines of the subject of the paper, he felt that any equation which included all the physical factors involved in such a heat transfer would unquestionably be too complicated for practical purposes. It seemed to him that there would always be necessary a simple equation, such as that of Osborne-Reynolds, including, perhaps, a few of the main physical factors. These together with experimental constants would serve to obtain desired quantities within certain ranges.

The temperatures taken by the author from the B. & W. experiments were derived by calculation, using the specific heat of the gases. The specific heats of gases, particularly at temperatures from about 1500 deg. fahr. up, were not well agreed upon by the best authorities. This variation amounted to several hundred per cent at 2500 deg. fahr. What was needed was some experiments where a heat balance could be taken which would show the possible inaccuracy of the data, plus or minus.

As to the accuracy of the formula, he would like to ask what the maximum possible per cent error would be if one were to solve it for some quantity, say, the length of a tube.

Gottfrid L. Ostgren asked whether there were any published data on formulæ to be used for calculation of heat transfer for large flues, over 2 ft. in diameter, or circular or rectangular cross-section. Frequently an engineer had to design a furnace where he was using waste-heat gases to heat air in a closed space, for instance, in an annealing furnace, and the question of determining the proper radiating surface in order to obtain a certain temperature in the annealing furnace was rather important. He had occasion to construct an annealing furnace of that type not very long ago, and while he had struck the temperature very closely, he had found that when doors were opened on the two sides of the furnace and the temperature dropped, it took a rather long time to get the temperature back again. By putting conical deflectors inside the flue, where the waste gases were passing, it was possible to obtain more contact between the heat units and the steel flue, which improved the transfer quite considerably.

D. S. Jacobus said that the heat-transfer rate of conduction from the gases to the cooling surface was only one of the elements to be considered in designing a boiler. For example, the effect of radiant heat on the tubes nearest the furnace was an important element, and unless this was included in an analysis of efficiency the results would be considerably in error. When it came to the final analysis and securing the maximum efficiency from a boiler, the rate of heat transfer must be considered, and it was necessary to balance up a loss in draft against securing a higher boiler efficiency.

There were a number of elements that had to be taken into account in designing a boiler; for instance, the effect of radiant heat. It was necessary to expose enough of the heating surface of the boiler to the radiant heat to keep the temperature of the furnace within the limit that present-day brickwork will stand.

[1] Asst. Efficiency Engineer, Carnegie Steel Co., E. T. Works, Braddock, Pa. Formerly with United States Bureau of Mines.

Again, the entering velocities of the gases between the tubes should not be made too high. If the area for the flow of the gases was unduly constructed there might be trouble, especially at the higher ratings at which boilers are run today, when the tubes become fouled through the accumulation of soot, which would lead to an excessive draft resistance.

It was also necessary to provide a sufficient furnace volume and a proper length of travel for the burning gases in order to consume the products of combustion, and also to prevent a blowpipe action on the boiler tubes.

An interesting addition to this valuable paper would be an analysis combining the draft losses with the variation of heat transfer to determine the theoretical proportion of the areas between the tubes for the flow of the gases to give a maximum heat absorption for a minimum draft resistance. An answer to this problem has been found by experiment and practice for certain classes of boilers, but it would be interesting to have

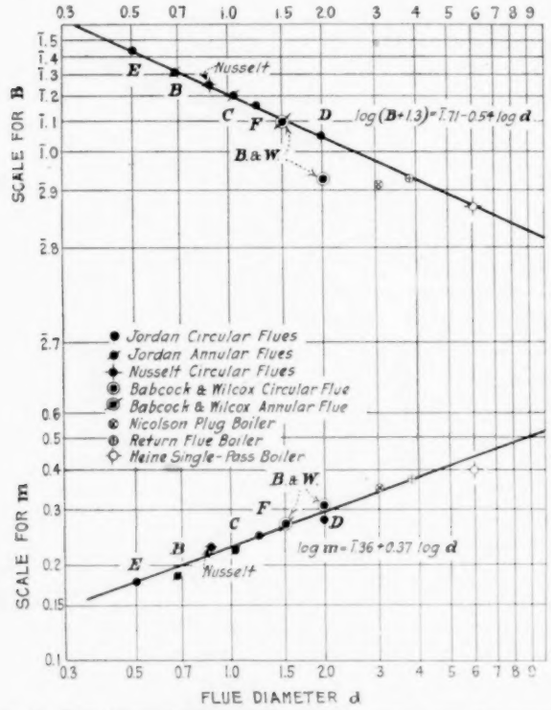



FIG. 2 RELATION BETWEEN FLUE DIAMETER AND COEFFICIENTS $B$ AND $m$ IN THE EQUATION LOG $M = B - m$ LOG $W/P$

a theoretical analysis of the proper way of proportioning the area for the flow of the gases.

Mr. Fry, in closing, said that Fig. 2 represented some work that he had been doing the previous week, in reply to Professor Fessenden's criticism that the lines could not be extended to larger flue diameters. It would be seen in the figure that the points for the Heine and Nicolson boilers that Professor Fessenden referred to, were well taken care of in both lines. If the Heine boiler tests of Professor Fessenden were replotted on the basis of weight of gas divided by perimeter, they would be found to show agreement with the author's lines plotted on the logarithmical basis.

He believed that a formula of this sort could be applied to the condition that Mr. Ostgren spoke of in air flowing through the inner flue, if it was possible to get the mean temperature of the flue wall.

In conclusion, he desired to point out that the paper referred to the point that was mentioned by Dr. Jacobus in regard to the loss of draft, viz., that by decreasing the flue diameter the rate of heat transfer could be increased, but that this would be done at the expense of loss of energy in forcing the gas through the flue. The loss of draft—loss of head—in passing through the flue was the price that must be paid for increased heat transfer, and if a formula similar to that used for loss of temperature could be obtained to take care of loss of head, it would be possible to figure out exactly what had to be paid for a given rate of heat transfer, and to calculate for any kind of a boiler with greater certainty.

He would add that two of the important series of tests mentioned in the paper were carried out by the Babcock & Wilcox Company, under the direction of Dr. Jacobus, who had courteously placed them at his disposition.

### MR. HOLMBERG PRESENTS PAPER ON SURFACE RESISTANCE

The next paper to be brought before the session was one by Messrs. H. R. Hammond and C. W. Holmberg,[1] which had been awarded the Student Prize for the year 1917. In introducing Mr. Holmberg, who presented the paper, Chairman Richards feelingly referred to the sudden demise, during the previous week, of Mr. Hammond, who had hoped to present it in person. The paper describes an investigation of heat transmission through glass and gives a formula by which the combined coefficients of transmission, as well as the conduction values for the glass inside air surface and outside air surface, may be calculated.

Prof. A. J. Wood, in a written discussion, called attention to the fact that tables, for the most part, give conduction values only. To apply these to the usual practical problems it was necessary also to know the values for the surface effect. The table in the paper showed the effect of temperature range on heat transmission, and this was found to influence the results to a considerable degree.

On December 3 Prof. R. B. Fehr and he had discussed, before the American Society of Refrigerating Engineers, the results of recent work at the thermal testing plant of The Pennsylvania State College. Among other constants given, it was stated that under usual temperature conditions and for "still" air, the total surface transmission for *both sides* of glass, corkboard and building paper was found to average about 22 B.t.u. per 24 hr. per sq. ft. per degree difference, which value was approximately 0.9 B.t.u. per hr. per sq. ft. per degree difference. Pending the results of more extended tests, this value was believed to be a safe one for general practice.

L. B. McMillan submitted a written discussion in which he said that the conclusions which the authors had reached regarding the importance of the air-film effect were in accordance with the theory on the subject and checked closely with the results by other investigators. However, their work showed more forcibly than ever the need for full and complete data on the subject of surface resistances.

Considerable work had already been done on this subject—much more than would appear at first thought. For example, it had been nearly one hundred years since Péclet made his classical experiments, determining radiation coefficients for a number of materials, and these, in connection with convection coefficients, indicated the rate of flow from the surface or conversely the surface resistance. One reason why there seemed to be such a scarcity of data on surface resistances was that this relationship of surface resistance to surface transmission was very generally overlooked.

Dulong had built on the work of Péclet and worked out equations for the radiation coefficients at various temperatures.

[1] 354 Senator St., Brooklyn, N. Y.

These were given in Kent's Pocket-Book, together with tables prepared by Box which facilitated the finding of the coefficient at any temperature. This would go a long way toward filling the need except for the fact that Péclet's coefficients had been found to be very considerably too low. For example, Paulding (Stevens Indicator, vol. 19, p. 393) has shown that Péclet's coefficient of 0.64 for iron was much too low, and that modern tests proved that this coefficient should be about 0.87.

Péclet's results were therefore of interest mainly for their historical importance, and because of the thoroughness with which he had attacked the problem, even at that early date.

Fig. 3 showed results of some of the modern investigations[1] as compared with Péclet's results, and illustrated how well the modern tests agreed, even though made by widely different methods. For example, the tests by Barrus, Brill, Jacobus, Eberle and that labeled "Stevens Indicator" were condensation tests, while those by the writer were by the electrical method, and yet the results were in very close agreement, while the curve showing Péclet's results fell far lower.

The data referred to were not presented as being directly comparable with the results presented by the authors of the paper under discussion, as these did not refer to glass surfaces. However, the data were of similar nature, as the results shown in the figure represented surface conduction for cylindrical surfaces where the character of surface was that of an ordinary steel pipe.

In pointing out the difference between Péclet's results and those of modern tests this was not intended as a criticism of Péclet's work, for considering the time at which it was done it was a great achievement, but now, with infinitely better facilities for research, we should repeat his work on even a larger scale than that which he attempted, and in addition to having the coefficients for various surfaces and laws showing how they vary with temperature, we should have also the laws showing the effect of wind velocity, humidity, etc.

This, however, would be a very large undertaking and could not be handled by one individual or concern, though some of the larger manufacturers of insulating materials had well-equipped laboratories and would be glad to coöperate in such a movement. The Bureau of Standards had done much creditable work along this line, and would probably do more, but great results could be accomplished in the university laboratories and experiment stations as had been shown by the paper under discussion.

The foregoing might appear at first thought to be rather much of an academic discussion, but it decidedly was not, and a few illustrations would show how useful these coefficients were in the solution of everyday engineering problems.

For example, a great deal of data regarding conductivities of materials was now available, and with complete information as to surface resistances the calculation of heat-flow problems would be much less of a bugbear than it had been in the past.

Furthermore, the only effect which wind velocity could have upon the heat losses from a surface was to decrease the surface resistance, therefore this effect could easily be isolated and determined. The same was true of air humidity, except where the material was affected by moisture.

As pointed out by the authors, the surface resistance was the greater part of the resistance to heat flow through good conductors of heat, and for accurate solution of problems of this kind accurate data on surface resistances must be had.

[1] Geo. M. Brill, Trans. A.S.M.E. vol. 16, p. 827. Geo. H. Barrus, Trans. A.S.M.E., vol. 23, p. 791. C. L. Norton, Trans. A.S.M.E., vol. 19, p. 729. Prof. D. S. Jacobus, Stevens Indicator, vol. xix, p. 12; Stevens Indicator, vol. xix, p. 388. Chr. Eberle, Verein Deutscher Ing., Mit. über Forschungsarbeiten, Heft 78. Thomas Box, Practical Treatise on Heat and Kent's Pocket-Book. L. B. McMillan, Trans. A.S.M.E., vol. 37, p. 921.

Furthermore, it was often desirable to estimate beforehand the temperature of the surface of a stack or furnace when the thickness and character of the walls and the temperature of the inside of the furnace were known.

As an illustration of the use of surface resistances in the solution of an actual problem, a 4-in. brick wall might be considered, the conductivity of the brick being taken as 6 and surface conduction as 2. This would make the rate of heat flow $= 1/[1/2 + 4/6 + 1/2] = 1/1.67 = 0.6$ B.t.u. per sq. ft. per deg. temp. dif. per hour. It was to be noted that the combined resistances of the two surfaces were greater than the resistance of the four inches of brick.

If in place of the brick the wall had been 4 in. of a good insulating material having a conductivity of 0.5, the rate of heat flow would then have been equal to $1/[1/2 + 4/0.5 + 1/2] = 1/9 = 0.11$ B.t.u. per sq. ft. per deg. temp. dif. per hour. In this case the resistance of the material was 8 times the combined resistances of the two surfaces.

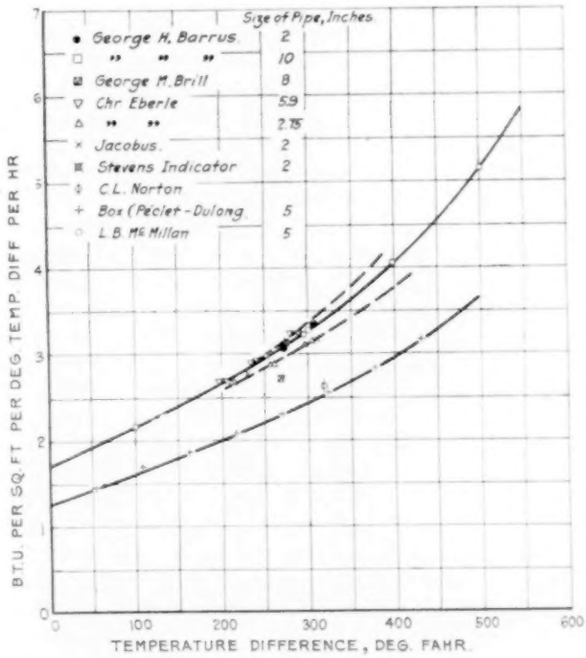



FIG. 3 COMPARISON OF RESULTS OF VARIOUS INVESTIGATORS ON HEAT TRANSMISSION FROM BARE PIPE SURFACES TO AIR

Therefore, while these things could be done with a considerable degree of accuracy, even with the data now at hand, it would be quite an advance to have full and complete information. This was particularly true regarding the good conductors of heat, for the data now available served very well in insulation problems where air resistance was the small part of the total resistance.

Returning again to the paper under discussion: The authors stated under Conclusions that the greater resistance was at the outside surface of the glass, and attention was called to the fact that this referred to the conditions of test and was not made as a general statement, as the resistance of the inside surface during these tests was greatly dissipated by the air circulation.

Also, it would seem from former investigations that the curves in Fig. 6 of the paper should bend upward at the higher temperatures instead of downward. However, a wider temperature range might be necessary to make this change con-

siderable, and for the given range the figures were probably very nearly correct.

In conclusion, he wished to repeat that he believed it would be well worth the trouble to investigate through a wide range of conditions the surface resistances of various materials.

Prof. E. A. Fessenden thought the temperature-gradient curves given in the paper were important, and it seemed to him that it might very well be emphasized in this connection that, where total transmission was being sought, the thermometers for measuring temperature should be placed at a considerable distance from the surface to get on to the horizontal part of the curves and away from the sloping gradient—possibly 10 inches or a foot or more away, but at least not near the surface.

Arthur K. Holmes called attention to the fact that in Fig. 5 the conduction of heat through glass seemed to vary between 18 and 22 B.t.u., while in another place it was stated that "the combined-coefficient values check up thoroughly well with the values 0.96 (dry glass) and 1.1 (wet glass) for a single window," or about one-twentieth as large.

L. B. McMillan said that in one case where the temperature went up to 500 deg. and the thermometers were placed at least 5 ft. away, unless they were shielded by a sheet of paper between them and the heated pipe, they would still, by radiation from the pipe, show a higher temperature than the room air. He therefore thought Professor Fessenden was quite right in saying that it was the temperature of the room air that should be taken as the lower temperature.

Mr. Holmberg, in closing, said that Mr. Holmes had mentioned that the conduction values given for glass seemed to be about 15 to 20 times those that were spoken of in regard to the combined-coefficient values as checking up fairly well with the values 0.96 and 1.1 for a single window. It was to be noticed, however, that in this connection it was said that, "Moreover, they [these values] show that the transmission varies linearly with the temperature differences." So, it would seem, they were speaking of transmission values. The transmission value took into account not only the conduction of the glass but the two surfaces, and it was the two surface values which so reduced the amount of heat that would go through there as to give that decreased value.

The glass itself was a very good conductor, and if taken by itself, without any surface resistance, there was very little resistance to heat going through; but with the two air resistances taken in conjunction with it, it gave the bottom curve on Fig. 5, marked "Transmission," which represents the value spoken of in the paragraph referred to by Mr. Holmes.

Lest misconception should arise regarding the conduction curves plotted in Fig. 5, he would say that the abscissæ represented total temperature differences (inside to outside of glass). As indicated in the table preceding the figure, the conduction curves were plotted merely for the purpose of comparison with the total-transmission curve. It was also to be noted that in formula [2] $k$ should be replaced by $1/k$.

### Mr. Baldwin Describes Apparatus for Purifying Air

The next paper, by W. J. Baldwin, described an apparatus for purifying air and regulating its temperature and humidity by mechanical means. In principle it consists of the use of a cold spray for the purification process, after which the excess moisture, together with particles of dust, excess $CO_2$, etc., are separated from the air by centrifugal action. In one of its original forms the device was applied to the porthole of a ship for the purpose of drawing into the cabin large quantities of air but excluding rain or spray. It has also been used to remove $CO_2$ from vitiated air, as in the compartments of a submarine, and for removing particles of dust from the gases of combustion in a chimney.

In lieu of reading the paper, Mr. Baldwin gave brief particulars of views which he had projected on the screen, showing various forms of the apparatus and uses to which it had been applied. The largest apparatus at present in use handled from 16,000 to 20,000 cu. ft. of air per minute. It was a dry apparatus and was used in the Flatbush Gas Company's plant on one of their boilers, and had been in use for over a year. It removed 96 per cent of the dust that would ordinarily escape up the chimney and 46 per cent of that dust was so fine that it would go through a sieve of two hundred mesh.

It was desirable, said Mr. Baldwin, not to use water when handling chimney gases. If water was used acids would be condensed, and the fuse would give out in a very short time, especially if salt water was employed. In New York and in Brooklyn where a salt-water spray running over an apron was used, it attacked the iron so rapidly that it disappeared in a few months.

In portland-cement mills the apparatus when operated dry would recover 83 per cent of the cement escaping from the top of the chimney, floating out over the country, and when water was turned on, 100 per cent.

The apparatus could also be used for throwing down and removing by-products from escaping gases from mechanical plants and gas-producing apparatus, etc.

### Mr. Akimoff Describes His Latest Balancing Apparatus

In the paper by Mr. Akimoff were described new methods which he has recently developed and applied in a new type of machine for combination static and dynamic balancing. In operation a clamp is attached to the body to be balanced, whereby a known centrifugal force is introduced when the body is rotated, for the purpose of neutralizing the static or dynamic unbalance of the body. By suitably constraining the motion of the rotating body, either the static or dynamic unbalance, or the combination of both, may be accurately measured through the adjustment of the clamp.

Clarence P. Crissey, who opened the oral discussion, asked the author if any rotors had been balanced on his machine and then run at or through critical speed, and if so, did experience indicate that it would be commercial to design multi-stage apparatus having packings between stages, with a critical speed below but in close proximity to the operating speed? In other words, could apparatus be balanced so closely that the critical speed could be disregarded?

In reply Mr. Akimoff said that he thought it was a problem different from dynamic balance. It seemed to him that dynamic balance proper ended when a body was balanced in such a way that in a perfect vacuum, without any outside effort, it would run perfectly and without any oscillation whatsoever. Machines could be built commercially, without very much trouble, because it was just as easy to get a near balance as to get perfect balance by the means described, and, of course, vibrations would not be set up except by the action of some outside agency. Torsional vibrations were an entirely different proposition and were due to the distribution of mass on the line of the shaft. The torsional problem, which was very difficult to solve, was illustrated by a plain shaft with a flywheel on either end.

H. G. Reist asked whether there was any method of marking the shaft or indicating where the counterweight was to go.

In reply Mr. Akimoff said that the amount and location of the counterweight were fully indicated by the position of the clamp, which could be quickly adjusted after a few trials. There was a way of making the clamp so that the adjustments could be made without stopping the machine, but that would be the subject of a communication by him at some future time.

Mr. Reist said that with reference to the matter of getting a balance that would run at critical speed, he might say that this was practically done in a different type of balancing machine in which the rotating body was supported by a flexible cable, but the effect was practically similar.

W. J. Baldwin described a method which he had devised and successfully used for balancing fans and other machines having parts attached to a central hub. It consisted of two radial arms adjustable at any angle to each other on the shaft of the machine. If these arms when both opposite the "heavy" side of the machine did not hold the machine in running balance, they were made heavier. If they were found too heavy they were shortened. Minor adjustments were made by moving slightly one of the arms.

F. Van Buren Connell said that recent developments in the automobile and airplane industries had emphasized greatly the subject of balance, which already was known to be very important, and was now considered a distinct branch of mechanical engineering and not a shop method at all. Up to the present time the methods of obtaining balance had been very crude. One of the old standbys had been the parallel ways referred to, which were only good for static balance, and then only under conditions of light weight and small journal bearing. With large journal sizes and heavy weights the results showed such a discrepancy that they positively prohibited the use of parallel ways for obtaining even static balance. With Mr. Akimoff's machine results were obtained with a mathematical exactness that had never been obtained before, and there was no guesswork about it—it was not a hit-or-miss system. By systematic trial adjustments they obtained the exact amount of unbalance and the exact plane in which they should drill or add weights to give that balance.

The subject of balancing was an extremely important one and a very practical one, too, because the actual work of indicating could be done by a mechanic. There should be an efficient balancing engineer, however, a new species, to direct the mechanic's work, because the subject required something more than the trial methods and the horse sense that had been applied to it so far.

Mr. Illmer's paper, an extended abstract of which was published in the October JOURNAL, was then presented by title. No discussion being forthcoming, the meeting was declared adjourned.

### PROFESSOR ANDERSON ON PLOTTING BLOWER-TEST CURVES

In his paper, which was presented by title, Professor Anderson described a new method of plotting blower-test curves, and demonstrated its utility by the solution of problems from graphically recorded test data.

Diagrams were given for impellers with blades tilted forward, blades radial, and tilted backward. Curves showed rates of discharge in cubic feet per second and volumes discharged per second per horsepower.

J. M. Spitzglass, in a written discussion, said that the curves given disclosed many interesting features in the characteristic properties of the various types of blowers, which could not be very well shown in the usual pressure-volume curve of the blower. It was interesting to note that in Fig. 1, representing the characteristic curve for blades tilted forward, the volume lines were uniformly converging toward the higher speed, so that some of them crossed each other, even within the limited region of the curve. This would indicate that at the higher speed of this special blower there was practically no variation in the pressure for any volume delivered by the blower, or rather the least variation in the pressure would change the volume from a maximum to a minimum, and vice versa, and it would be very inefficient to use a blower of that kind where a more or less constant volume of air was required.

In Fig. 2 the volume lines were less converging than in Fig. 1, while in Fig. 3, the characteristic curve for blades tilted backward, the volume lines were practically parallel to each other, which meant that in this kind of blower the volume of air delivered could be kept more or less uniform, even though the resistance to the flow should vary to a certain degree.

In this experimental case the discharge of the fan was varied by the use of different-sized orifices at the outlet of the fan. In the practical operation of blowers it was not so easy to control the resistance offered to the flow of the air. The air might be blown through a thick fuel bed, which might vary in height and also in resistance, and in such cases it was not the static pressure, nor even the mechanical efficiency, that interested operators as much as the number of cubic feet per horsepower that could be obtained from the blower, and curves plotted in this manner showing the amount of air that could be obtained for any condition were very valuable for that purpose, because they showed at a glance under what conditions it was possible to obtain the maximum quantity for a given amount of power used on the blower.

Regarding the mechanical efficiency shown for the given blowers, he wished to ask why the efficiency was so low, not being much over 40 per cent in any one of the given blowers, and why the blower with the blades tilted backward showed the lowest efficiency of all, when theoretically this kind of blade should show higher efficiency than the others.

F. R. Still wrote that while the author's curves were interesting, and perhaps might be valuable for some purposes, he thought the most useful curves for all purposes of fan or blower application were those of the kind employed by the American Blower Company, which were developed from characteristic curves plotted from test results. In his opinion, no other method covered the performance of a fan so completely, and at the same time cleared up what otherwise was so frequently very puzzling in results from fan installations, especially to those who did not have to deal with fans frequently enough to understand them thoroughly.

G. F. Gebhardt wrote that he had applied the authors' curves to comparative tests of a number of fans of various makes, and found that the commercial characteristics most desired were brought out in a much more satisfactory manner than with the customary method of plotting results. It was true that considerable time was required to plot the curves as indicated, but the ease with which the various problems involved might be calculated from the graph might greatly justify the initial expenditure of time. No claims were made in the paper as to the accuracy with which the investigation was conducted, but he had had the privilege of studying the test methods used and had been greatly impressed with the painstaking and exacting care with which all measurements were made and recorded. The paper, though brief, was a marked acquisition to the art of blower testing. He would like to ask the author

why the capacity curves between 0 and 35 cu. ft. per sec., Fig. 1, had been omitted.

C. M. Spalding wrote that the curves given in the paper brought out very clearly certain phases of blower action, and that it would be very desirable if the author would add some definite information about the dimensions of the fans, and would also tell whether the blades were plain or curved, etc.

In examining the data presented, he had been interested to see what other aspects of the matter would appear by taking the information furnished by the author and comparing it in other relations, more especially as regarded the relative performance of the three types of fans. He had constructed the tables which follow by taking two values as a common basis for all three types of fans and setting against them the variable values of the other items covered in these data. The variable items were stated both in the actual values taken from the curves and in the proportionate values by assuming some one of the three types of the fans as unity, or rather 100 per cent, and comparing the performance of the other two types of fans. It would be noted that these tables did not select the most favorable condition of operation of all three types of fans, as in order to make the comparison it was necessary to select as a common basis points which appeared on all three of Professor Anderson's curves, but even with this limitation they were very interesting.

TABLE 1 COMMON BASIS: PRESSURE AND R.P.M.

| Basis | | | Performance | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Total Output, Cu. ft. per sec. | | | Efficiency, Cu. ft. per sec. per hp. | | |
| Press., inches water | R.p.m. | Values | Blades tilted forward | Blades radial | Blades tilted backward | Blades tilted forward | Blades radial | Blades tilted backward |
| 1.50 | 1400 | Actual | 73.0 | 57.0 | 32.5 | 15.00 | 17.95 | 20.05 |
| | | Relative | 100.0 | 78.0 | 44.5 | 74.80 | 89.50 | 100.00 |
| 1.25 | 1400 | Actual | 76.3 | 60.9 | 39.5 | 15.10 | 18.40 | 21.40 |
| | | Relative | 100.0 | 79.8 | 51.8 | 70.60 | 86.00 | 100.00 |
| 1.00 | 1400 | Actual | 80.0 | 64.1 | 45.0 | 15.20 | 18.90 | 22.45 |
| | | Relative | 100.0 | 80.1 | 56.3 | 67.80 | 84.30 | 100.00 |
| 1.25 | 1300 | Actual | 68.0 | 54.6 | 31.2 | 17.35 | 21.05 | 23.50 |
| | | Relative | 100.0 | 80.3 | 45.8 | 73.80 | 89.70 | 100.00 |
| 1.00 | 1300 | Actual | 72.0 | 58.2 | 37.4 | 17.50 | 21.70 | 25.20 |
| | | Relative | 100.0 | 80.9 | 51.9 | 69.50 | 86.20 | 100.00 |
| 0.75 | 1300 | Actual | 75.0 | 61.8 | 43.1 | 17.62 | 22.30 | 26.57 |
| | | Relative | 100.0 | 82.5 | 57.5 | 66.40 | 84.00 | 100.00 |

TABLE 2 COMMON BASIS: TOTAL OUTPUT AND CU. FT. PER HP. PER SEC.

| Basis | | | Performance | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Pressure, inches of water | | | Rev. per min. | | |
| Total output, cu. ft. per sec. | Efficiency, cu. ft. per sec. per hp. | Values | Blades tilted forward | Blades radial | Blades tilted backward | Blades tilted forward | Blades radial | Blades tilted backward |
| 40 | 16 | Actual | 2.40 | 2.16 | 1.93 | 1278 | 1405.0 | 1612.0 |
| | | Relative | 124.30 | 112.00 | 100.00 | 100 | 110.0 | 126.1 |
| 40 | 19 | Actual | 2.14 | 1.83 | 1.52 | 1182 | 1295.0 | 1477.0 |
| | | Relative | 140.70 | 120.30 | 100.00 | 100 | 109.5 | 124.9 |
| 40 | 22 | Actual | 1.77 | 1.55 | 1.17 | 1100 | 1220.0 | 1382.0 |
| | | Relative | 151.20 | 132.40 | 100.00 | 100 | 110.0 | 125.8 |
| 50 | 16 | Actual | 2.12 | 2.02 | 1.70 | 1282 | 1433.0 | 1680.0 |
| | | Relative | 124.70 | 118.70 | 100.00 | 100 | 111.8 | 131.0 |
| 50 | 19 | Actual | 1.80 | 1.63 | 1.25 | 1196 | 1329.0 | 1546.0 |
| | | Relative | 144.00 | 130.20 | 100.00 | 100 | 111.0 | 129.4 |
| 50 | 22 | Actual | 1.32 | 1.32 | 0.87 | 1122 | 1258.0 | 1440.0 |
| | | Relative | 151.70 | 151.70 | 100.00 | 100 | 112.0 | 128.2 |
| 60 | 16 | Actual | 1.87 | 1.63 | 1.29 | 1333 | 1470.0 | 1770.0 |
| | | Relative | 145.00 | 126.30 | 100.00 | 100 | 110.3 | 132.8 |
| 60 | 19 | Actual | 1.40 | 1.23 | 0.78 | 1238 | 1378.0 | 1615.0 |
| | | Relative | 179.30 | 157.60 | 100.00 | 100 | 111.2 | 130.4 |
| 60 | 22 | Actual | 0.92 | 0.89 | 0.37 | 1143 | 1300.0 | 1490.0 |
| | | Relative | 248.70 | 240.50 | 100.00 | 100 | 113.6 | 130.2 |

TABLE 3 COMMON BASIS: TOTAL OUTPUT AND PRESSURE

| Basis | | | Performance | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Efficiency, Cu. ft. per sec. per hp. | | | Rev. per min. | | |
| Total output, cu. ft. per sec. | Press., inches water | Values | Blades tilted forward | Blades radial | Blades tilted backward | Blades tilted forward | Blades radial | Blades tilted backward |
| 45 | 2.000 | Actual | 17.75 | 16.90 | 14.95 | 1219.0 | 1378.0 | 1703.0 |
| | | Relative | 100.00 | 95.10 | 84.20 | 100.0 | 113.0 | 139.8 |
| 45 | 1.625 | Actual | 20.70 | 20.27 | 17.25 | 1145.0 | 1281.0 | 1583.0 |
| | | Relative | 100.00 | 97.90 | 83.30 | 100.0 | 111.9 | 138.3 |
| 45 | 1.250 | Actual | 23.50 | 24.33 | 20.25 | 1071.0 | 1184.0 | 1463.0 |
| | | Relative | 100.00 | 103.60 | 86.30 | 100.0 | 110.5 | 136.6 |
| 55 | 1.750 | Actual | 17.45 | 16.67 | 14.90 | 1250.0 | 1430.0 | 1775.0 |
| | | Relative | 100.00 | 95.50 | 85.40 | 100.0 | 114.4 | 142.1 |
| 55 | 1.375 | Actual | 20.38 | 19.80 | 16.80 | 1175.0 | 1338.0 | 1670.0 |
| | | Relative | 100.00 | 97.20 | 82.50 | 100.0 | 113.8 | 142.1 |
| 55 | 1.000 | Actual | 24.42 | 23.60 | 19.30 | 1100.0 | 1246.0 | 1565.0 |
| | | Relative | 100.00 | 96.50 | 79.00 | 100.0 | 113.2 | 142.2 |

The author in closing said that Professor Gebhardt brought up the point of why the curves between 0 and 30 cu. ft. per sec. had been omitted in Fig. 1. This was due to the fact that for less than 30 cu. ft. per sec. the curves overlapped and would have been indistinguishable in the small scale to which the figures were drawn for the cuts. Curves drawn to a larger scale than shown in the figures illustrated the performance of the blowers very clearly.

He had not yet had the privilege of reading Mr. Still's remarks, but had no doubt that the information he had to offer would be instructive.

Mr. Spitzglass' application of the curves to forced-draft practice was important. Another application was that to ventilation systems where it was necessary to move air against the friction in the ducts. The correct speed for a certain friction head and volume might be readily selected, or if the friction head was diminished by shutting some of the air outlets the proper blower speed might be determined from the chart and the blower slowed down, resulting in economy of power.

# FURTHER DISCUSSIONS OF VARIED PAPERS

## Proceedings of the Second General Session at the Annual Meeting, with Authoritative Papers by F. W. Dean, L. C. Loewenstein, H. L. Gantt, C. J. Ramsburg and C. H. Bedell

AT the second General Session of the Annual Meeting, at which Vice-President Arthur M. Greene, Jr., presided, the following seven papers were presented, the first, by F. W. Dean, and the last four—contributed by Local Sections—being read by title:

AN ACCOUNT OF THE ENGINEERING WORK OF E. D. LEAVITT, F. W. Dean.

A VOLUME REGULATOR FOR BLAST-FURNACE ENGINES, L. C. Loewenstein.

EXPENSES AND COSTS, H. L. Gantt.

BY-PRODUCT COKE AND COKING OPERATIONS, C. J. Ramsburg and F. W. Sperr, Jr., contributed by the Philadelphia Section.

THE SUBMARINE, C. H. Bedell, contributed by the New York Section.

COMBINED STRESSES, A. Lewis Jenkins, contributed by the Cincinnati Section.

THE TRUMBLE REFINING PROCESS, N. W. Thompson, contributed by the San Francisco Section.

### DR. LOEWENSTEIN PRESENTS HIS PAPER

The paper presented[1] by L. C. Loewenstein dealt at length with the problem of properly regulating the quantity of air supplied to blast furnaces and had for its main object the description of a new instrument, named a volume corrector, which, when used in connection with an impact-float constant-volume governor, will correct for any changes in the temperature, barometer and humidity, so that the air supplied to a blast furnace will, at all times, under any atmospheric conditions, deliver a perfectly definite and predetermined weight of oxygen to the blast furnace, and is so designed that it requires only one setting for each correction.

C. P. Crissey, in a written discussion, said that, in addition to the methods mentioned, it was also perfectly commercial and good practice to test turbo-blowers by means of a nozzle placed at the inlet, which made it unnecessary to disarrange the discharge piping or waste the air.

Referring to the author's remarks on the orifice method of measurement, he stated that he was unaware of any objection to attaching a parallel section at the end of the orifice. On the other hand, experience had not shown this to be necessary when the nozzle was properly shaped. The impression should not be gained that nozzles without the straight portion were inferior in accuracy or in any other respect.

The author had described a very ingenious device, but it was not automatic in its operation, and until something automatic was developed he believed that tables and charts would be more satisfactory for use in giving equivalent settings for the sliding weights on the scale beam of the air meter.

R. J. Wysor,[2] in a brief written discussion, said that the author assumed that a constant weight of air should be delivered to the furnace under all conditions, whereas, from an operating standpoint, it was frequently found advisable to change this weight for different furnace conditions, beyond that corresponding to varying atmospheric conditions. Again, the author took no cognizance of leakage after the blast had left the blower, that is, through the cold-blast main, stoves, hot-blast main and bustle pipe, with the numerous valves, seams and joints, offering opportunity for loss of air. This loss in different plants varied from probably a minimum of 5 per cent to a possible maximum of 25 per cent. And at each furnace it was a widely variant quantity due to changes in pressure and temperature of the blast, atmospheric conditions, state of repair of the system, etc. In other words, no matter how accurate the governing device might be, there was still considerable difficulty in delivering a fixed weight of oxygen to the furnace per unit time.

Linn Helander thought that a clearance space of 7 per cent was rather high, and that 3 per cent was more usual; also, that the variation in pressure of from 10 lb. to 30 lb. seemed a very large increase in pressure for a single blowing engine.

Again, as to the clearance in which the expansion of the air occurs, at the end of the stroke the pressure was up, and it was full of high-pressure air. Assuming that the pressure went down to atmospheric at a point further on, it would be necessary to subtract the clearance volume from the corrected volume, which would be 7 per cent from the 11.8 per cent mentioned in Par. 7, or 4.8 per cent.

Dr. Loewenstein, replying to Mr. Crissey, said that a nozzle without a straight portion could be used, but in that case there was no way of telling whether the jet as it left the nozzle covered the entire area.

In regard to using tables or charts for setting the sliding weights, he would say that there were three variables, and an infinite number of combinations. As to the barometer, this could be set to each 0.1 in. of variation in the instrument. Similarly, there were an infinite number of variations of temperature and humidity, and any one who had attempted to get up a set of tables or a set of curves would realize how difficult it was and how voluminous it would be, and second'y, how much easier it would be to use the instrument by the three settings, and automatically get the reading, than to go over a set of tables and probably make a mistake. Also, the superintendent in walking through a blast-furnace plant could easily check up the three settings by the operators and see that the barometer, temperature and humidity were exactly corresponding to the instruments hanging close to the main instrument. He could not do that as readily if he had a set of tables to check.

In reply to Mr. Helander he would say that the statement as made in the paper was absolutely correct in reference to volumetric displacement, because the clearance space between the cylinder head and the piston was not the entire space. It included all the spaces down to the valves, and it was positively known that the volumetric efficiency of blowing engines was seldom above 85 per cent in operation. The statement that a blowing engine could go from 10 lb. pressure to 30 lb. pressure dealt with extremes that did not occur in ordinary blowing, but distinct cases were known where a blowing engine normally

[1] To be published in the March issue of THE JOURNAL.
[2] Blast Furnace Department, Bethlehem Steel Co., South Bethlehem, Pa.

operating at 12 to 15 lb. went all the way up to 30 lb. when the clearance tightened up.

### MR. GANTT DISCUSSES EXPENSES AND COSTS

H. L. Gantt then presented his paper on Expenses and Costs, in which he claimed that there were in every manufacturing enterprise expenses which did not contribute either directly or indirectly to the production of goods. Such expenses, he maintained, should not be considered as a part of the legitimate cost of the goods, but should be kept in a separate account. Further, the expenses in this account should be classified according to their various causes, and strenuous efforts should be made to eliminate these causes and thereby reduce this non-productive expense. This was particularly important in time of war, when all of our energy was needed for productive purposes.

Frederick A. Alden, in a written discussion of Mr. Gantt's paper, said he thought that one of the most vital causes of idleness of machinery was apt to be the fact that one machine might be adapted for but one or a few operations, while if a more universal type of machine had been purchased other operations might be performed on it. In advising upon the exploitation of a new manufacture, he had always maintained that unless such manufacture was of a major type, it would be one which would cause idleness at times due to lack of demand for the finished article, as most articles had a variable demand. Hence, that unless a variety of articles could be manufactured upon the same machine with a slightly different setting, the manufacture of the article in question would not be a paying proposition. Many companies made but one or a few lines of goods or fabrications, and in consequence always had certain machinery idle at times. One remedy for this idleness would be the manufacture of auxiliary products or by-products.

Many factories had machinery and stock idle which had ceased to be useful through breakage and wearing out of the former and no demand for the latter. He felt strongly that anything which could not be used within a reasonably short time should be sold, if salable, junked if not salable, and if neither of the above were possible, converted into fuel or disposed of as rubbish. There was too great a tendency to hold on to machinery and material hoping that it might be used some day. Considering the cost of such holding, which is the cost of idleness, including storage costs, use of valuable space, further depreciation, loss of interest on investment, a rapid and early conversion into available cash should always be the rule, based upon immediate possibilities as stated.

Major Frank B. Gilbreth commended the paper in unstinted terms. The principle Mr. Gantt had called attention to, he said, carried a little further, was identical with the scheme of dumping American manufactures abroad. In other words, the average cost accountant, if let alone, would so sprinkle certain costs that he could go to the management, particularly to the financial management, and boast of the fact that he had but a trifling amount remaining undistributed somewhere. That might be a proof of great merit among cost accountants, that they had distributed and redistributed cost items, but the more they were distributed and redistributed improperly, the more the self-deception, and if a plan had been laid out for the distribution of overhead expenses among various items for a normal business, how could more money be made by making more than it was originally intended to make and not distribute or redistribute any part of the overhead expense?

Major Gilbreth then described an improved arrangement of bulletin board that would make possible a quick judgment on this matter, by means of which the head of a sales department with a single glance could tell which of a certain bank of machines that had been brought together on account of their mnemonic classification, were going to run out of work, and could then go out and telephone to neighboring shops for immediate work, if necessary, and take on jobs which would keep down the idle time, as Mr. Gantt had pointed out. The board also showed the names of those men handling machines who had been proved to be the most efficient on them, which seemed to definitely help out the employment department in "evenizing" the necessary shifts that had to be made among the machines.

Henry Hess disagreed with the author that the matter under discussion was primarily a question to be solved by engineers rather than by financiers. There was a time in the history industries, he said, when there was a sharp line of cleavage between the shop, the so-called production end, and the office, usually termed the non-productive division, each managed by specialists. That was the heyday of the engineer and producer, and the financier, as separate people. If that period had not actually passed, it certainly was passing, and it was rather unfortunate that the author should apparently reaffirm this unfortunate division.

There should be no consideration of an important question of cost of production by the engineer as an engineer, or by the financier, as a financier. Any such question must be considered by both. The broad statement was made that certain expenses due to relative inefficiency of production were not part of the legitimate cost of goods. There always would be and must be some not absolutely necessary costs, the amount varying with relative efficiency of business management in a given business, and that cost must be and would be passed on to the consumer. An increase caused by an undue amount of such cost would simply lead to a refusal on the part of the purchaser to buy the goods, and therefore the consumer thus automatically applied the necessary corrective.

So far as Mr. Gantt's suggestion involved a careful subdivision of costs, it was wholly admirable, provided that each such subdivision was for the purpose of its careful scanning, with a view to its reduction. It was this reduction that was of importance, regardless of the allocation of any element of cost to any group of accounts.

Adolph L. De Leeuw, referring to Mr. Gantt's statement that there was no great difficulty about getting the expense for material and expense for labor, asked if, say, 30,000 tons of pig iron were bought at $14 a ton, and a year later 20,000 tons were left, and the price of pig iron had gone up to $58 a ton, what was the expense of the material? If it was said that the material should be charged at $14 a ton, well and good; but if the 30,000 tons gave out, and 30,000 tons were purchased at $58 per ton, on the expectation that it would go up to $80 in the near future, but instead the price went down again to $14 a ton, then what would be the price of the material? $58? But who would buy the product on the basis of $58 for pig iron?

There was no question about the advisability or the desirability of keeping a plant working, but in the plant with which he was connected there were large portions of the buildings devoted entirely to special operations, and each machine used was absolutely good for one operation and one piece and for nothing else. Furthermore, even if they did not increase the capacity, and should run the shop 50 hours a week, they all knew there were 168 hours in the week. Was this machinery

idle for the other 118 hours? If it was and the shop ran overtime, then was it idle or negatively idle?

A. L. Williston said that most manufacturers he had come in contact with seemed to regard overhead as one of those mysterious things that could not be analyzed, that it was necessarily a constant. It was not a constant, and Mr. Gantt had called attention to one of the variables that affected it. A very large percentage of all the confusion in the matter of accounting had been due to the fact that we were in the habit of expressing costs in figures and we had been confused in thinking that costs which were expressed in figures were a constant. There was hardly a single item of cost in any manufacturing operation that was a constant, and we should get into the habit of thinking of these things as variables, studying the laws of their variation, instead of thinking of them as constants and trying to memorize those constants.

Walter N. Polakov thought that the points raised by previous discussers were relatively unimportant compared with the big question: If it costs us something to do nothing, why shall society at large pay for our inefficiency and for our idleness? In England and France and Italy the slogan now was, "The idle hand assists the enemy," and we might equally well say that the idle machine assisted the enemy, because the fact was that if we left our machinery idle or inoperative, the results were the same as those due to the sinking of our ships, the blowing up of munition factories or the burning of grain elevators.

His work in the public-utility and power-plant field had been such as to make him believe the idleness question was just as important, if not more so, in that particular branch of industry as in others with which he was not so familiar. Mr. Polakov then had thrown on the screen a chart representing averages obtained from some seventeen power plants and showing that but half the capacity was utilized on the average daily run.

Carl G. Barth called attention to the fact that twenty-five years ago F. W. Taylor had covered everything that had been brought up by the previous speakers and that he had done as much for accounting as he had in the management of the plant and in other details. It was his hope that he could eventually give the world the benefit of what Mr. Taylor did.

H. M. Wilcox said that in the standardization and wage-payment systems which had been developed, attention had been concentrated almost entirely on productive labor.

He could say from personal experience that a very complete analysis of idle-machine time had shown the Winchester Repeating Arms Co. where it could eliminate a great deal of time, and in a great many instances they had been able to establish standards and definite forms of wage payments other than day pay to compensate their so-called non-productive workers for what they had done in limiting the idle time of equipment and organization.

As to the effect of idle-machine time on cost, from their present data, covering six or eight months, they had plotted the curve shown in Fig. 1, and had found that the average curve drawn through all the points, amounting to several hundred, was an equilateral hyperbola. The shop factor was taken as the actual burden earned by the machinery at machinery-hour rates divided by the actual burden charged against the various shops. The first 5 per cent of idleness, it would seem, had little effect on the cost; the next 10 per cent had more, and the more inactive the machinery became the more rapid the losses were. He believed that in the reconstruction period after the war this question of idle-machine time would be one of very vital importance.

Carl G. Barth said that he considered the most vital thing in cost was that it be known where every penny went. The first thing was to be able absolutely to tie up every expense, no matter how it was done. Most people, however, used an overhead expense factor that they had inherited.

His method was to get the most simple distribution of the expenses, without any analysis whatever—put it all on wages, but tie up the cost so that he would have the whole burden. Next, he took the expense item for each department, in labor. Then he found a more equitable way of dividing the more general expenses of the various manufacturing departments, so that each department was separated, and then they were responsible for what they got from the office and the other auxiliary departments. Then he went through the cost on the basis that each problem was a whole, and finally, in the last refinement, he distributed it.

The author had said that he did not know what to do with the expense of idleness. In his opinion he would have to charge it to profit and loss; and nothing else could be done with it.

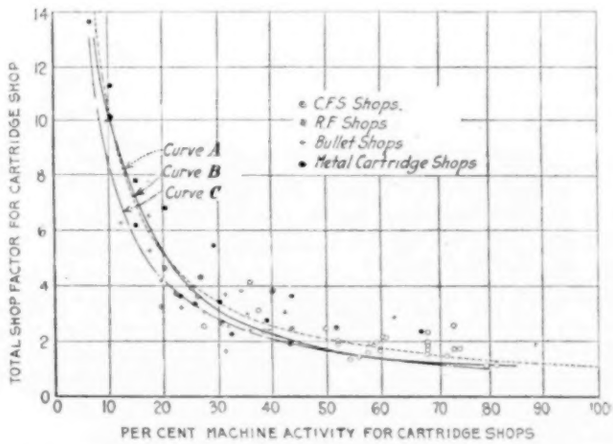



FIG. 1 RELATION BETWEEN MACHINE ACTIVITY AND TOTAL FACTOR FOR CARTRIDGE SHOPS

(48 hours per week = 100 per cent activity)
Curve A:—Plotted from monthly reports of May, June and July, 1917.
Curve B:—Geometric equilateral hyperbola of equation $xy=100$, where $x$=per cent machine activity and $y$=shop factor.
Curve C:—Theoretical equilateral hyperbola of equation $xy=80$.

Mr. Gantt, in closing, said he had suggested the year before that the expense of idleness might be put in profit and loss, as mentioned by Mr. Barth. He did not care whether this was done or not. If one man put it on profit and loss and the other put it on his product and based his selling price on the cost of his product and the other did not, the one who did not would not sell his goods in competition with the other man, and then he would have more of his plant idle and more of this item to consider.

Two years ago a man had told him the cost on a certain article was 30 cents a dozen and that they could be bought for 26 cents a dozen, and had asked him whether to buy them or make them. The cost consisted of 8 cents a dozen for material, 10 cents for labor and 12 cents for overhead, and the plant was running one-third full. On being told that the overhead if the plant ran full would be about 5 cents a dozen, he had said to the man that if the plant was run full the cost would be 23 cents instead of 30. A competitor running full time

would have less cost and so would sell where he could not, making the man's cost go up more because he would have still more idle time.

Mr. Hess had been more fortunate than he had in the fact that the financiers had not interfered with the operation of his plant. His experience was that as soon as the engineer began to show the plant was being interfered with by the financier who did not know anything about manufacturing, then the trouble began.

If we could show those expenses attributable to management and mismanagement, and show where they belonged, instead of placing them on the workmen, we could soon make the salesmen and the financiers sit up and take notice. It had been done in a number of cases, and no one who was using this method would think of giving it up.

So high an authority as the Chief Constructor of the United States Navy, referring to his paper presented last year on this general subject, had said that it was the only system he knew anything about which would do justice to the arsenals and the navy yards.

In regard to Mr. De Leeuw's questions, no general answer could be made. There were some present who had been wrestling with these questions for the past two years, and they were satisfied with the answers they had reached. The answer would not be the same in different plants. He would not think of a set of rules to go by, for rules without fundamental principles were as misleading as they could be. If we got the fundamental principles right and could not work out rules, we were on the wrong job. If we worked out the fundamental principles and could not apply them, we must get something to help us. In the past we had tried to run things according to precedent and by rules; and we had reached the end of it. The old business schemes did not work any longer. It was necessary for us to eliminate waste and expense, and not cover them in the product and give them to the public to digest. If we attempted to digest them we should be beaten by Germany.

# A SESSION ON TEXTILE SUBJECTS

## With Authoritative Papers on Labor-Turnover Records, Accident Prevention, and Moisture Content of Textiles, and Discussions by Textile Men.

THE Textile Session of the Annual Meeting was held on Thursday, December 6, at 2:30 p.m., under the auspices of the Society's Sub-Committee on Textiles, Vice-President Charles T. Plunkett acting as chairman. Three papers were presented at this session, namely:

LABOR-TURNOVER RECORDS AND THE LABOR PROBLEM, Richard B. Gregg.

ACCIDENT PREVENTION IN THE TEXTILE INDUSTRY, David S. Beyer.

THE MOISTURE CONTENT OF TEXTILES AND SOME OF ITS EFFECTS, William D. Hartshorne.

### MR. GREGG PRESENTS HIS PAPER

In the first of the papers to be read, Mr. Gregg considered the various causes that have given rise to the serious problem involved in the shifting of workers from one factory to another, and urged that the same rational methods of analysis be employed in its solution that have long applied in the cases of production and factory-operation problems.

Albert L. Pearson, commenting on the author's mention of illumination of work place and amount of accident risk as two important causes for labor turnover, wrote that in designing a lighting system the aim should be to have illumination which would approach, as nearly as possible, daylight efficiency in production. As a result the workmen would be better satisfied and the amount of second-quality work would be reduced. Good lighting was conducive to cleanliness and helped to prevent accidents. Moreover, a well-lighted place was attractive, while a dimly or poorly lighted place was just the reverse.

Lewis Maxfield wrote that as long as any concern persisted in maintaining low wages, long hours of service and unsanitary factory conditions, it would experience a large labor turnover because its employees would be continually leaving for factories where the conditions were the reverse of those mentioned. There was no doubt but what the labor problem was what it was today just because we had failed to remember at all times that the laborer was human and should be treated accordingly. It was indeed true that industrial conditions as affecting the worker were changing for the better, but there still remained a considerable field for improvements.

Walter M. Kidder wrote that the aim of all investigation of the subject under discussion was to disclose the cause for the rate of labor turnover. The best experience of those who had given the subject ample study was that foremen were not likely to ascertain the real reason for quitting in a large number of cases, or to place it on record uncolored by their own attitude respecting each of them. It was vital to get at the real reason in order to bring it under future control. In some cases it could be learned by some other person much more dependably, for example, by the employment agent, or superintendent, or paymaster, or by some officer or member of the firm who had a faculty for gaining the confidence of employees. In every case of voluntary quitting this step should be taken, even though it added to the burden of some busy man to listen to the stories he must hear in order to sift out the basic truth of the real cause.

George H. Perkins cited a remarkable instance of low turnover in the mill of the Naumkeag Steam Cotton Co. of Salem, Mass., which was destroyed by fire in 1914; 20 months later, shortly after starting the rebuilt mills, it was found that 72 per cent of the 1600 old employees were at work in them.

Lawrence W. Wallace said that the manufacturing plant with which he was connected had worked out a comprehensive program for combating the problem of labor turnover, and that in spite of the chaotic conditions at the present time and the unrest, in recent weeks the tendency in their labor-turnover curve had been downward. He would suggest that valuable information would be found on this subject in the Annals of the American Academy of Political and Social Sciences, and a great deal of the material they had in their program came as suggestions from reading in those publications.

W. D. Hartshorne thought that the sum mentioned by the author for the cost of training a spinner was very small, and the method of training might account for it. As a rule, the

method of training spinners was to put them on a job and let them go at it, and this generally involved a great deal of cost.

Arthur C. Jackson said that, on the theory that the proper place to draw workers from was the immediate vicinity of the plant, his company was making an industrial census of the community within a radius of one mile from the plant, and advertising the desirability of working within walking distance of home and in a shop that had certain attractions which they felt theirs had. In this way they hoped to reduce the turnover somewhat.

Herbert M. Wilcox thought that in formulating a constructive program for reducing labor turnover, an important factor was recognition of length of service. This should be not only in the form of wage remuneration, but in the conferring of soms sort of stripe or medal, so that old employees would hold a more honorable position with the organization than men who had been employed a comparatively short length of time.

Charles H. Bigelow said that the company with which he was connected was now furnishing every one of its 1000 employees with a paid-up insurance policy, based on six months' employment, of $500. For each year they had been in the service $100 was added, up to $1000. That, he thought, would keep down the labor turnover to some extent, because a man got some benefit by staying with the concern. The company carried the policy as long as the man remained in their employ.

Arthur Brewer said that his concern, the Bridgeport Brass Company, had adopted the same scheme of life insurance and had also insured employees against accidents which might occur within or without the shop, and also in the case of sickness.

By way of addition to Mr. Wallace's remarks, the author stated that both the May 1916 and May 1917 issues of the Annals of the American Academy of Political and Social Science contained excellent material on methods of reducing turnover. This was an aspect of the problem that his paper did not attempt to deal with.

R. F. Burnham[1] said that in his plant, employing about 5000 men, in the last two years and a half they had taken on over 20,000 men, the turnover had been that great. Recently they had adopted the method of placing all the labor under an employment manager, who had the authority for hiring and discharging all men. If a man sent out to a foreman did not suit the latter, the man was not discharged, but was sent back to the employment manager and put in another department. If he did not fit there, they kept on trying him in various places, and finally when the right groove was found the man stayed. In that way they had reduced their labor turnover fifty per cent by endeavoring to place the man in the work he was adapted for.

When a new man came into a department, the foreman was instructed to give him some attention and teach him what his work consisted of—to do a little welfare work, a little uplift work—and make the man feel that he was a part of the organization. By doing that they made the men content. After two years of service the men received a certain bonus.

Welfare work, visiting nurses, recreation halls, etc., were necessary for the men, especially at the present time when they had a disposition to rove somewhat.

[1] Hercules Powder Co., Kenvil, N. J.

Ambrose B. Dean gave interesting details of a part-time method of vocational training successfully adopted in a textile-manufacturing city by the Board of Education, of which he is a member. Those students that had been in the classroom for three days, or a week, then went, under the school authorities, into the mills, and along with the employees there put into practice, as far as possible, the theories that had been taught in the classroom; and those who were already in the mill would then return to the schoolroom for their three-day stay or corresponding period.

In many of the mills men were discovered who were more or less advanced in years, who had never had the opportunity of scholastic education, many of whom could not read a blueprint, and many of whom did not understand a simple formula. Attempts made to get them into the regular vocational schools were not successful, owing to the sensitiveness of the older men in regard to associating with younger men in school work. This situation was successfully met by organizing a class for the employees of a given mill, and, under the direction of the school authorities, appointing a college-graduate employee of the mill as teacher of the class, the mill owner contributing the time of this teacher and furnishing the classroom.

E. B. Smith said that in the case of machinist training, those who had graduated from apprentice schools, or otherwise, he had found the labor turnover depended on one feature—selling the operator to the company. If the manager, foreman, gang boss, leader or monitor, failed to sell each operator to the producer, the result would be a large turnover.

The turnover caused the most expense in the case of the old experienced hands, who usually had a psychological reason plus a financial reason for their actions in relation to the company. The psychological reason lay in the training of the old hand and the financial reason in the pay envelope. Work going to an operator from a previous operation in a defective condition was the cause of much trouble, and that was due to the improper training of the operator performing the previous work. It all resolved down to the question of the individual operator under consideration: Was he or she trained right?

They had found that the principal way in which to hold the old operator was to let the company appreciate he or she was an old operator. Rewards and badges of merit were good, a Christmas envelope of five per cent of the yearly wages was also good. But in any case the operator must be contented and satisfied or he would leave.

Their practice was to break the operator in first and then to try to fit the round pegs in the round holes. They had found on a particular operation where ten weeks was ordinarily required, that intensive supervision brought it down to ten days. This meant that we must employ these intensive methods if we were to fit the female for the work which the male had been doing. The males were going to the front and the females were taking their places, and we must analyze step by step each operation and cut out the heavy manual part of the work where we could, in order that the female could take it up, and then we must train her and treat her so that she would be satisfied. The chief thing was to have the operator satisfied with the pay envelope, and to get that the operator must be trained right, the machine must be right, and the work coming from the machine must be right.

P. A. McKittrick said that the company with which he was connected built textile machinery, and in one of their plants

where about 1600 workers were employed they found that the labor turnover was about 120 per cent, nearly all of it in the first year. If they could hold the man a year they could hold him then as a more or less permanent employee.

During the last two years it had been necessary to make many general advances in wages, and in the last advance they adopted the plan of giving each man in their employ up to three months extra pay each month at the rate of 4 per cent of his monthly wages; from three to six months he would get 6 per cent; from six to nine months, 8 per cent; from nine to twelve months, 10 per cent; and in the case of those employed over twelve months, 12 per cent. They had put the plan into operation just at the time when the Liberty Loan was being exploited, and as a result 1300 of their men had subscribed about $65,000, using this extra pay to pay for their bonds. They were quite sure the plan would cut down their yearly turnover.

The chairman called attention to the fact that the author had said that the question had been asked: Will it be wiser to leave the broad problem of control of labor turnover entirely in the hands of employers, or should the state or labor unions have a voice in the control? and inquired if that was an intimation that the employer had had the control in his hands, or that it should be left there.

Mr. Gregg, in replying to the chairman's question, said that he did not think the employer had control now, but as time went on he would get it more and more, and he was personally inclined to think that with the development of employment exchanges, which were very probably coming in this country as they had come in England and in the Continental countries, we may see a method of control of labor turnover for specified districts. That system might be developed by the state, but probably the labor unions would have a voice in its development.

He urged that care be taken to remember that the greater part of labor turnover is not a malady in itself, but is important primarily as a symptom of dissatisfaction or discontent.

### MR. BEYER DISCUSSES ACCIDENT PREVENTION IN THE TEXTILE INDUSTRY

In presenting his paper, Mr. Beyer emphasized the fact that the textile plants had an abnormally high proportion of mechanical accidents, giving the reasons therefor. He then discussed fully various devices for safeguarding existing and new machinery, and presented for consideration a set of safety standards in actual use in a textile plant which specify the safety equipment for gears, sprockets, dangerous projections, pickers, cards, doublers, drawing, winding, ring spinning and twisting frames, looms, etc.

John W. Upp, in a written discussion, said that few realized the vast number of minor accidents that occurred in our workshops and factories, or had any adequate conception of the aggregate cost of such accidents until they made up their yearly reports or looked at tabulations of accidents such as were presented in Mr. Beyer's paper. As we gained in experience, we found that the majority of these accidents were preventable if we installed safety appliances and then saw that these appliances were guarded and kept in place after the first installation.

He was very much pleased to find that the author recommended those machine guards which were interlocking, and that they compelled the operators to use them. Belts, fortunately, were beginning to give way to direct drive, but there were still enough of them in use to warrant special attention being given to the guarding of machine belts, for they were even more hazardous to the woman worker than gears.

In the various factories in which he was interested they had found their safety-committee work the most profitable single undertaking with which they dealt. They gave the committee complete authority, so that they could discipline those operators who jeopardized their own interests, or those of others, when they removed guards, and they analyzed each accident report and did not dispose of it until they had indicated a means of prevention of similar accidents in the future.

George R. Wadleigh said that, in regard to the belting, particularly in the spinning room, which is equipped with what is known as the Lockwood, Greene drive, it seemed impossible in that case to run a belt guard from the floor up to a height of 6 ft. This, in his opinion, was more or less unnecessary, but at the same time it was the law in some of the states. Another requirement in several of the states was a screen around large belts. In their records of accidents going back five years, in a number of textile mills they had only one case of any one being injured by falling against a main driving belt.

The author, replying to Mr. Wadleigh, said that he had never been in sympathy with the 6- or 7-ft. height specified for the belt guard in some cases. He had asked a number of safety engineers if they had ever known of an accident in a case of a belt guard which was run to a height of 3 ft. 6 in. from the floor, and had never been able to find a record of such an accident which could have been prevented by the higher guard. A committee of engineers of the insurance companies he was connected with was working on this matter, and had called a conference to be held December 11 in New York, to which representatives from the New York, Massachusetts, Pennsylvania, New Jersey, Wisconsin and other labor departments were invited, in an effort to get uniform standards adopted in all these states which would be practicable and would not go too far, as it was now felt some of these standards did. He thought it would be of great value to the employers in the different states and quite a step forward if this could be done.

W. G. Duncan said that manufacturers had had a great deal of trouble, not only in regard to the lack of uniformity of standards between one state and another, but between the various whims of the different state inspectors. He thought also the legislatures had made a mistake in passing laws which were entirely too mandatory, and leaving to the safety department of the state or the chief engineers and inspectors no room for the exercise of any judgment whatever. His company had been very much annoyed in putting on a set of guards which were satisfactory to the state department one year, and then being told the next year that they were worse than useless, and must be replaced by something else. It seemed to him that the first step in this matter was to bring about a standardization of safety devices.

P. A. McKittrick emphasized the need for standards, stating that his company sold machinery to manufacturers in nearly every state in the Union and practically every country in the world, and that it was necessary for them to have very many sets of patterns—what was good and sufficient for one was not for another. This burden was entirely on the ma-

chinery builder, because his company had never succeeded in getting any recompense for the additional work.

D. E. Douty told of his difficulties in endeavoring to comply with the requirements of an insurance inspector in a plant of moderate size, and suggested that the standardization of such officials would be an excellent thing.

Richard B. Gregg[1] asked the author whether there were any figures which showed the distribution of accidents throughout the day and week; that was to say, were there more accidents the first thing on Monday morning than there were the first thing, say, on Thursday morning? Were there any more accidents at the end of the working period along at 11.30 or 12 o'clock, or 5.30 or 6 o'clock, than there were at other times in the day? He thought that was sometimes an element in the human factor which was overlooked, as sometimes we ascribed accidents to sheer carelessness which were really due to fatigue of the operator.

Allan D. Risteen said, in reply to a previous speaker, that all insurance companies certainly did need a standardization of inspectors, for inspection was largely a question of standardization. It was the custom of his company to have their inspectors, after they had visited a plant, indicate in their reports about how soon they thought the plant ought to be visited again, and if an inspector found it necessary to go to a plant every six or eight weeks, he did not know whether he thought it was altogether the fault of the inspector or not.

William D. Hartshorne said that in regard to the time of day accidents occurred, for some 10 or 15 years he was connected with the Arlington Mills at Lawrence, Mass., where they kept an accurate account of every accident, the hour at which it occurred, the cause of it, and every detail about it, and he would say that there was no question but what there was a material difference in the nature of the accidents which occurred at different hours of the day, and that there were many accidents which occurred on Monday morning which, taken in connection with the circumstances which surrounded them, were certainly well worthy of special consideration.

S. C. Coey said that he had made somewhat of a study of the time of day of accidents in the steel industry, and found that in the case of the Youngstown Sheet & Tube Co. the greatest number came along in the morning hours, about 10.30, and that thereafter another peak in the accidents occurred in the afternoon. The peculiar thing about this time of greatest accidents was the fact that it was at the same hour as the peak in the power curve, showing that the rate of doing work in the plant and the number of accidents had a certain definite relation. He had been connected with Celluloid Company of Newark for the last few months, and had had a curve drawn up along the same lines, which showed the same general results in that industry as in the steel industry.

Allan D. Risteen said that in making reports of accidents, where the hour was not recorded at once, there was a certain psychological factor that influenced the man who was filling out the blank not to set the hour at opening or closing time, but somewhere in between. He did not mean to say that that caused the curve to have that characteristic, but there was certainly an influence of that kind which tended to emphasize the curve and should be considered when statistics were being studied.

[1] 814 Flatiron Bldg., New York City.

Mr. Beyer, in closing, said that he desired to speak a word in behalf of the machinery manufacturer, and that was this: that the man who used the machinery was paying the money, and he was really the one who held the key to the situation. They had found that in the U. S. Steel Corporation—when they got out definite specifications for new machinery, showing what they wanted, the manufacturer gave it to them, but until they adopted that plan they had quite a variety of results. That would be taken care of by the definite standards suggested in the paper—the machinery builder would know what he had to give, and the employer would be assisted in securing the best.

The question of an overhead belt guard had been raised, and he knew of one or two cases of serious injury or death from the breaking of overhead belts. That did not happen often in any one plant, but where there were several thousand plants located in each state a number of accidents occurred every year, and he thought it was desirable to guard 12-in. belts or over—when they were fast-running belts.

The question of standardization was largely up to the insurance inspector and state inspectors in getting uniform results, but he thought the Society could exercise an excellent influence in bringing about a more general uniformity in standardization.

The question of the time of day at which accidents occurred had been pretty well discussed. He had made a number of such analyses and studied a good many others, and found that almost invariably both in this country and abroad the accident rate increased gradually until within about an hour of the end of the turn, both in the forenoon and afternoon, and then dropped off. There it seemed that the employees got their second wind and began to pick up a little and look toward the closing of the day. That was such a constant condition that he hardly thought it could be due to the makeup of the report, and he thought it did represent the psychological and physical condition of the employee. In regard to a relation between the peak of the load and the frequency of accidents, the load in the textile industry was apt to be pretty even, so that there was not the variation due to the human factor that would be found, say, in the steel industry.

## Mr. Hartshorne Reads Paper on Moisture Content of Textiles

In the third paper to be presented, Mr. Hartshorne discussed at length the effect of moisture content on the weight of textile materials, and set forth certain laws governing the regain in cotton and worsted which he had developed after an extended period of investigation, together with numerous charts and tables for facilitating calculations.

Walter M. Kidder, in a written communication, commended the paper highly. He said that the author raised but did not answer one question that was of the greatest importance because of the magnitude of the cotton industry in this country, namely, whether or not it was of advantage to increase the humidity of the air in the successive processes of manufacturing. It was a matter of importance to have this determined authoritatively.

The effect upon quality which the author showed results from varying conditions of moisture constituted a powerful argument for the maintenance of uniformity in each department of the particular condition which was most advantageous. To accomplish this in practice called for intelligent application of the law that he had enunciated, but also would

require the exercise of engineering skill in many cases, for the flow of air currents within some factories extended throughout the entire structure, and differences in degree of humidity in different departments were correspondingly difficult to maintain. It was also true that it was difficult to maintain uniformity of humidity in all parts of one room under the best conditions.

Willis H. Carrier thought that Mr. Hartshorne's paper had gone into the subject with extreme thoroughness, and that it was a contribution to the subject which would be permanent, largely because of the methods he had adopted.

The subject, however, had a very much wider bearing on paper. It was very important, he thought, perhaps, even more important than, in the case of textiles, because in the subsequent treatment of paper and sizing and calendering, the moisture content had to be procured for the best results with great accuracy. The same was true of tobacco and practically all hygroscopic substances where moisture content was important in the process.

There was one product he had in mind where the installation was bad, the material was wet, and they wanted to dry it down to 10 per cent moisture. But if they had sold it on the basis of 10 per cent moisture, it would have been at a loss, so finally the moisture was reduced to 0.25 per cent, which was made possible by his knowledge of the laws enunciated by Mr. Hartshorne. That was a very important application, for that one-half or one per cent they got in the week's production, something like $100,000, meant $1000 or so.

The effects of differences in vapor pressure were very important in calculating rates of drying which occurred in various hygroscopic substances, and it would be desirable if Mr. Hartshorne would carry out his investigations at higher temperatures, temperatures beyond 100 degrees, where a great deal of the drying was done, in order that the laws could be investigated there as well as in the normal temperatures of the room.

Mr. Hartshorne, in closing, thanked the previous speaker for his comments. The question of the relation to drying, he thought, was an exceedingly important one, and he had mentioned it in the paper in several places as being affected in ways which might not be understood. That subject needed more investigation, and he would be very glad to undertake it if he had a research laboratory available.

Referring to Mr. Kidder's communication, the question to which he alluded as having been raised but not answered, Mr. Hartshorne agreed was very important, and he was of the opinion that it needed careful investigation under practically workable conditions, with complete understanding and controlled knowledge of results, to demonstrate what are the best obtainable effects both as to quality and quantity of product. It could be done, and for the benefit of the cotton industry it ought to be done authoritatively.

# WORK OF THE BOILER CODE COMMITTEE

***THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.***

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in THE JOURNAL, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 177-180, inclusive, as formulated at the meeting of November 9, and approved by the Council on December 4, 1917, and the interpretations of the Committee in Cases Nos. 181-184 inclusive, as formulated at the meeting of December 6, 1917, and approved by the Council on January 18, 1918. In this report, as previously, the names of inquirers have been omitted.

### CASE NO. 177

*Inquiry:* Is the type of removable dome as shown in Fig. 13 for use on h.r.t. boilers permissible under the rules of the Boiler Code, or is it necessary that this dome be attached direct to the shell with a double-riveted flange for pressures over 100 lb.?

*Reply:* The construction shown in Fig. 13 is considered as a steam boiler drum and not a boiler dome, and therefore does not come under Par. 194 of the Boiler Code.

### CASE NO. 178

*Inquiry:* An interpretation is requested of the application of Par. 253 to the drilling of rivet holes in crowfoot braces. Is it permissible to punch holes in the shell full size where the brace is fastened thereto?

*Reply:* It has been proposed to revise Par. 253 to read as follows:

> 253 *Drilling of Holes.* All rivet holes and stay-bolt holes and holes in braces and lugs shall be drilled full size, or they may be punched not to exceed ¼ in. less than full diameter for material over $\frac{7}{16}$ in. in thickness, and ⅛ in. less than full diameter for material not exceeding $\frac{7}{16}$ in. in thickness, and then drilled or reamed to full diameter. Plates, butt straps, braces, heads and lugs shall be bolted in position for drilling or reaming all rivet holes in boiler plates except those used for the tack bolts required in assembling. Tack bolts for seams shall be not over 12 in. apart.

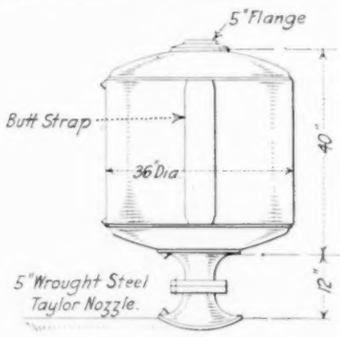



FIG. 13

### CASE NO. 179

*Inquiry:* In the use of steel castings for the construction of locomotive boilers, what class shall be used under the speci-

fications for steel castings given in the A.S.M.E. Boiler Code?

*Reply:* It is the opinion of the Committee that unless the Code specifically distinguishes between Class A and Class B, either class is permissible.

### CASE NO. 180

*Inquiry:* Is it permissible when calculating the maximum allowable pressure on a furnace of a vertical tubular boiler that is staybolted and less than 38 in. in diameter, to determine the pressure that would be allowed under Par. 239 for a plain furnace, and then add the pressure which would be allowed according to Par. 199 for the supporting value of staybolts?

*Reply:* It is the opinion of the Boiler Code Committee that your inquiry is answered by the reply in Case No. 57 and the reply in Case No. 113*a*.

### CASE NO. 181

*Inquiry:* Is Par. 239 of the Boiler Code correct, as interpreted in Case No. 22, in its application to plain cylindrical furnaces? Under the interpretation of Case No. 22, a Lancashire type boiler with a single furnace 30 ft. long by 4 ft. diameter, built of 11/16 in. sheets, would be allowed a working pressure of only 29 lb.

*Reply:* There is no rule in the Code for the calculation of the pressure to be allowed on this particular construction, as Par. 239 is limited in its application to furnaces whose length is not over six diameters. If plain furnaces of these large dimensions are to be used without Adamson rings or other reinforcements, they must be stayed as specified in Par. 240.

### CASE NO. 182
(Annulled)

### CASE NO. 183

*Inquiry:* Is the rule in the Boiler Code requiring double stop valves on the steam pipes of boilers set in battery applicable to boilers of the locomotive type where no openings are made for entering them and the danger of scalding any one working inside does not exist?

*Reply:* It is the opinion of the Committee that Par. 303 does not make specific reference to any particular type of boiler, and therefore fully answers this inquiry.

### CASE NO. 184

*Inquiry:* It is desired to use, solely for heating purposes, a h.r.t. boiler with 4 in. flange for connecting the gravity returns from the heating system. Is this allowable, or does a boiler of this construction come under the limitation of the Code as to size of blow off?

*Reply:* If the construction is to be solely used for low-pressure heating purposes, the rules for heating boilers apply, and no limitation in size of blow-off is required for that class of boiler (see Par. 364). If, however, this boiler were to be used for power purposes, it would be necessary to limit the blow-off size as described by Par. 308.

# CORRESPONDENCE

***CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.***

## Scheme of Gaging for Screwed Parts

TO THE EDITOR:

The trend of machine design, as found in the bicycle, automobile and airplane, indicates an increasing demand for better screw-thread fits.

This is not only desirable for standard bolts and nuts, but it is imperative for screw threads that enter into the design of a machine in which the greatest strength for given dimensions is required.

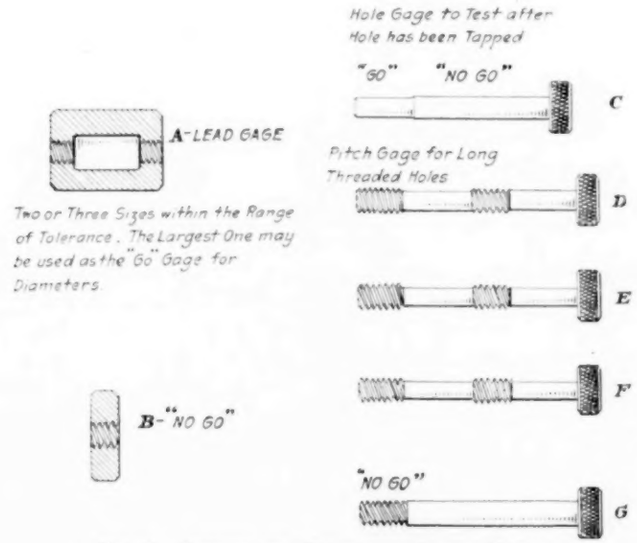



FIG. 1 SYSTEM OF GAGES FOR SCREW PARTS

One of the steps in betterment of the lead of die-cut screws is set forth in a paper by the writer, entitled A Screw Die for the Turret Lathe, Trans. Am. Soc. M. E., Vol. 19, p. 77.

We know how high may be the price paid for a poor fit in an obscure place of this kind, especially in the life of the flier, but if such carelessness runs through all the work, it may actually result in turning the tide of battles and final results of the present war. The contemplation of the full significance of this and other elements of machine design keeps us continuously keyed up to the keenest appreciation of our obligations.

Much advance has been made in the production and gaging of the screw, but the nut or internal thread has not shared in this advance.

The flow of metal under stress of the so-called wrench fit makes it possible in a moderate length of contact to force a nut over a screw in which there has been a marked difference in both the form and lead of thread. Many screw-thread fits that are most satisfactory in common practice do not give an even distribution of the working stress. As a matter of fact, where there is a difference in lead, the stress within the length of the nut may be added to the working stress.

Many ways have been considered for the improvement of the internal thread, but our practice is still very unsatisfactory, especially when viewed from the needs of the airplane.

The purpose of this comunication is to emphasize the need of greater care in cutting internal threads and to suggest a system of gaging that will give a more definite indication of the character of the fit. The importance of greater care in cutting internal threads is not only from the needs of more dependable product, but in keeping with modern practice it may even reduce the cost of product.

The system of inspection should give most careful scrutiny to the means and methods for producing the work. This is particularly necessary in connection with internal threads in which the length and diameter are so proportioned that it is impossible to see the condition of the thread.

We should know the pitch and lead of the tap, and we should also know the lead and other dimensions of the work produced by the tap.

The leading end of the tap may produce a larger hole than the part following, so that the whole length of the tap may not serve to control the lead. In fact, it is known that the first few threads of a tap generally determine the advance, and that there may be a very strained condition if the contact of the following threads conflicts with the tendency of the leading threads.

Experiments in which the shank of a tap has been threaded to fit a nut in order to insure the advance of the cutting end of the tap in the work, have shown that even with a short thread in the cutting part of the tap, well backed off, there is a conflict between the control of the lead screw on the shank of the tap and the natural advance of the cutting end, so that any lost motion in the lead screw or any yielding between the lead screw and the cutting end results in a similar degree of error in lead of thread produced in the nut.

In die and tap making it is found that the final hardening of the cutting edge of the die and the tap results in changes that are not uniform, and that it is desirable, in the production of work in which the greatest strength is required for a given weight, to use only those dies and taps that are known from the first to produce satisfactory results, and the product of these should be inspected not only at first but from time to time during their use to insure their maintenance of accuracy of lead. The first inspection may result in discarding 10 to 90 per cent of the taps, but this cost is very small compared with the cost entailed by the production of work that is not uniform in diameter and lead.

This, coupled with the inspection of the form of the cutting edges of the taps and dies, constitutes one part of the inspection, and it should be remembered that what is said of the inspection of the taps applies to both the roughing and finishing taps and dies, providing two are used.

If the lead of the roughing tap is not true, the use of a finishing tap may leave a thread that will seem satisfactory in any ordinary gaging method, and yet one of most undependable character.

The proposed scheme of gaging which is presented for discussion is offered with full knowledge that it may make it necessary to discard a large percentage of taps and dies that have been made for this purpose and that it will require a little more care in inspection, but notwithstanding this apparent handicap, it will not, in the writer's judgment, reduce the output of finished product but will tend to increase the dependability that is of paramount importance.

Everyone knows that interchangeability is of greatest value from the production standpoint, yet interchangeability has in some cases been sacrificed to obtain a fit that would be satisfactory according to the sense of feeling; that is, a finger fit or a wrench fit.

It is well known that a screw fit that at first is what is called a wrench fit may become a finger fit after it has been screwed in and out a few times. It is also known that if both screw and nut are of perfect form and true lead, no such great change takes place by merely screwing the two pieces together a number of times.

The system of gages, both internal and external, includes a "go" and a "no go" gage, but these are supplemented by pitch gages. If the total range of tolerance for the thread of the nut is 0.003 in. at the pitch diameter, there should be two or three gages provided for the different pitch diameters coming within the range of tolerance for the nut. The largest of these gages that will enter two or three threads must pass easily through the entire nut.

For long threads, such as found in airplane turnbuckles and the cylinder sleeve of one of the airplane engines, the pitch gages should be made as shown at *D*, *E* and *F* in Fig. 1. Turning out the middle of the gage eliminates some of the obscuring effects due to crooked holes or to particles of grit lodged midway in the fit.

The limit of tolerance of these gages should be made to conform to the special requirements of the work.

It is conceivable that in some kinds of work it may be desirable to give the nut and screw a slight difference in lead so as to equalize the stress of each thread, to compensate for any difference in extension that may exist between the screw and the nut when subject to the working stress.

The "go" and the "no go" diameter gages should be short and of perfect form. The lead gages may be a trifle flat on top of the thread to insure clearance.

JAMES HARTNESS.

Springfield, Vt.

## Accuracy vs. Precision, and the Gage Problem

TO THE EDITOR:

A gage is an instrument indicating physical limits, employed in measuring duplicate parts.

Manufacturing tolerances are the established limits of parts which will properly function.

It is obvious that there must be a definite amount of clearance between male and female components. The maximum clearance should be made as large as the nature of the work will permit, and the minimum clearance should be made as small as will permit of the ready assembling of the parts. Thus we will establish the maximum manufacturing tolerances which represent the rejection points. To insure uniformity of manufacture within these established tolerances, gages are made to check the rejection points. Allowances must be made to take care of inaccuracies developed in the construction, and use of, these gages provided to accept or reject the work.

Minimum male and maximum female gages, made to the extreme tolerances, soon become unserviceable by wear, as work which is beyond the established tolerance will be acceptable to such gages.

Maximum male and minimum female gages should be made as near the extreme limits of tolerance as manufacturing conditions will permit, for work passed by these gages after becoming worn will be within the established tolerances.

Extreme refinements in gage manufacture are most expensive, and are unwarranted by the functioning of ammunition components. The variation of gages within the established tolerances (operating to reduce the manufacturing tolerance of the component) is an economic question which concerns only the manufacturer. All gages within the established tolerances of the component which are acceptable to the manufacturer as master, inspection or working gages should be accepted.

These are basic principles controlling the manufacture of interchangeable parts and the standardization of gages therefor.

The gage problem is a simple problem if we leave it so. The details of its operation require constant supervision, but

this supervision is only necessary to insure that we do not leave the straight and narrow path.

Many attempts have been made in the past few years to develop a science of gages that would either automatically run itself, or that would enable inexperienced or untrained persons to control it. The writer has come in contact with several of these attempts, and has observed their rise, decline and fall, each scheme going through very similar successive phases. Schemes developed by novices without experience of actual conditions; elaborate, expensive and inefficient; appearing ideal on paper, but disregarding basic principles; developed as an end in themselves, instead of as a means to an end; finally discarded and the matter handled in the simple and direct manner that governs the other manufacturing tools.

A gage is a manufacturing tool. The purpose of a manufacturing tool is to aid production. A gage should be used as a preventive and not a cure. Gages properly used increase production and reduce scrap. If this result is not obtained there is some basic fault present.

There are two kinds of results in regard to dimensions obtained in manufacturing. For want of better terms, we will entitle them accuracy and precision. These two results are often considered as identical; in fact, if ideal conditions could be maintained they would be identical, but in actual practice these local conditions are seldom, if ever, met with.

In ordinary manufacturing practice, precision only is obtained. Precision is sufficient for a plant which manufactures only its own product. It is only when several separate factories are working independently of each other to produce a common product that a greater degree of accuracy is required.

Let us consider the true meaning of this factor that we are calling "precision." By precision we mean the relative variation that develops between similar parts. For example, we will assume that we have a part to manufacture that contains a hole which we wish to make 0.500 in. in diameter. In the manufacture of these parts we obtain a product in which the difference between the largest and smallest holes does not exceed 0.005 in. in diameter. This would mean that our limit of precision was 0.005 in. for this dimension. The size of the corresponding part which is to assemble into this hole would be developed in relation to the size of the hole obtained, allowing the necessary clearance. It would not matter if the absolute size of these parts was off 0.008 in. or more, as long as the requirements of precision are met. As time goes on, the absolute sizes often fluctuate in actual practice; but as long as the relative precision of the companion parts is maintained and the quantity of production is balanced, the results obtained are satisfactory. Whether or not this is the most economical method in the long run is an open question.

In order to maintain accuracy, all the requirements of precision must be met, and, in addition, all checking and testing instruments and other standards must be compared against a fixed standard. This results in the following situation: If a tolerance of, say, 0.004 in. is given for any dimension, if precision only is required, the whole 0.004 in. is available for a manufacturing tolerance. If accuracy, however, is required, and as it is impossible to make our testing instruments without some degree of error, all errors in our testing facilities are subtracted from the total permissible tolerance, thus actually giving us a smaller manufacturing tolerance. The more nearly accurate our checking facilities are, the greater the per cent of the tolerance remaining for manufacturing variations.

The confusing of these two factors—accuracy and precision—has been the cause of many difficulties and misunderstandings, particularly during the past three years, in the manufacture of munitions. A company would take a contract to manufacture certain articles to specified limits of accuracy. This company had manufactured their own product to similar limits of precision, or assumed that they had, and foresaw but little difficulty in meeting the requirements. But when the actual production started, and they were required to maintain the specified degree of accuracy, they discovered that there were much more severe conditions to be met than they had ever contended with before.

The establishment of manufacturing tolerances is too often based upon assumptions rather than definite records of past performances. For example, some time ago I personally made some tests at a plant covering a period of a couple of months, to determine, among other things, what their normal variation in milling cuts amounted to. This company was an old established concern, produced work of the highest quality, and had a very complete inspection system. The use of limit gages, however, was not general. In many cases only a "go" gage was provided, and all work was required to "fit" this gage. This company assumed that all work which passed this inspection did not have a total variation of over 0.001 in. They were so certain of the fact that they would not have hesitated to give sworn evidence that they could hold their milling cuts within a limit of 0.001 in. But the tabulation of several hundred measurements of the same dimension on similar pieces revealed the fact that their normal variation in milling cuts amounted to over 0.005 in. instead of only 0.001 in. Similar conditions exist in many other plants.

Another striking example in this connection is in regard to threading tools and gages. The producers of these articles will only guarantee their product to a limit of error which seems excessive in comparison with their specifications of a few years ago. As a matter of fact, these tools are practically the same as those made in the past, but the facilities for checking them have been so improved that discrepancies are now discovered which in the past had been assumed to be very much smaller. These examples could be multiplied almost indefinitely.

The answer to this whole problem is to face the facts, and base all plans upon the results of actual tests and investigations rather than upon assumptions. If the conditions are known we can take steps to meet them. As long as they are not known or understood, difficulties will constantly arise—difficulties that result in almost unending delays and extra expenses.

The following is suggested as one of many possible plans that will operate economically, simply and efficiently:

The logical first step toward producing accurate work is to provide physical standards, or master gages, to control the gages. These standards represent the rejection points: all gages within these limits are satisfactory; all gages beyond these rejection points are discarded. The design of these standards is not of great importance, except as it assists in the verification of the inspection and working gages. In the majority of cases a master of the same design and construction as the gage gives very satisfactory service. For profiles, tapers and other similar forms, a male master for a female gage is often the most efficient.

A drawing, properly dimensioned, gives those dimensions which it is essential to maintain. This automatically controls the design of the gage, indicating the points for which gages must be provided. It also thus specifies the holding points for the work, as it is a self-evident truth that the work must be located in relation to the cutting tool from those points on which a gage is applied.

The construction of the gages should be carried out under the same general principles that govern the construction of the tools. If a tool, or gage, tends to wear larger, the policy is to make it as small as is consistent with the manufacturing conditions without going beyond the rejection points. If the tool, or gage, tends to wear smaller, the reverse is true. Extreme refinements in measurement or construction only become necessary as they approach closely to the rejection points.

After the gages are completed and checked against the rejection points they may be graded according to the requirements. We will assume that there is a shop inspection and a final inspection. This would require three groups, one for the machine operators, one for the shop inspection, and one for the final inspection. Those gages which show the greatest amount of variation within the rejection points would be given to the machine operators. Those measuring closest to the rejection points would be used on the final inspection. The intermediate gages would be used for the shop inspection.

An efficient gage inspection is imperative in any case. Under this plan all gages of the same type would be inspected and regraded at the same time, and the proper distribution again made.

All persons who handle the gages should be properly instructed in their use. It should hardly be necessary to say this, but in the past much unnecessary expense has been caused by abuse of gages. The final inspectors should establish the standard method of applying the gages to the product, and all other inspectors should be instructed accordingly.

This plan would entail the minimum gage expense and insure the maximum of service from each gage. This plan includes all types of gages.

Owing to the fact that thread gages involve such a large number of factors, it might be advisable to discuss this subject in some detail.

The main function of all threads in ammunition components is to hold two pieces together, and it is advisable to use standard forms of thread wherever possible, as the various factors of these standard threads are definitely established and extensively tabulated.

A thread is cut with a tool carrying a fixed form, whether this thread is made with a tap or die, chased on a lathe or milled. It is therefore evident that a variation in the diameter of one factor will be accompanied by a corresponding variation in all other diameters cut at the same time with the same tool. Statements have been made to the effect that the pitch diameter was the most essential factor of a thread, and efforts have been made to control that diameter to closer limits than the other diameters, but the statement is fallacious, and the attempts were unsuccessful.

The pitch diameter of a screw is that diameter where the thickness of the thread and space are equal. Its only function is to locate the angular flanks of the thread. If a standard form of thread is employed, this function becomes useless, because a standard form of thread carries with it a definite relation of these flanks with the outside and root diameters. The pitch diameter of the male thread does not coincide with the pitch diameter of the female thread. The essential requirements of the threads used on ammunition components are the angle or flank of the thread in contact, the load and the amount of contact between male and female threads. In most cases the ammunition is so designed that the "set back" due to firing would hold the parts firmly in position without any threads, so that the main consideration on such threads is that they be sufficiently strong to hold the parts together during transportation and handling.

In those cases where the "set back" must be withstood by the thread, one of sufficiently coarse pitch should be used, so as to allow of liberal tolerances and still retain sufficient strength to meet all conditions.

It seems to the writer that instead of profiting by the experience in this work that has been gained by the manufacture of large quantities of similar articles for several of the foreign governments, particularly in regard to threaded parts, and of going on from where that work left off, we are starting almost at the beginning, and have still to solve again many of those problems that were well advanced. For example, on many tapped threads the British inspection consisted of the use of a "go" or minimum plug thread gage, which would insure interchangeability, and a "not go" or maximum plain plug gage which would insure a sufficient area of contact. A visual inspection of the thread would insure that the shape of the thread or width of flats at the root diameter was sufficient to give the required strength, as the factor of safety in regard to its strength was large, and any weak threads that met the requirements of these two gages would be very evident at the visual inspection.

The gage problem is about what we make it ourselves. If we attempt to create an elaborate and exacting system of gages considering the subject as an end in itself, we will but store up for ourselves future trouble and great expense. If we consider it in its true light, as a means to an end, and handle all its many details in the same manner, and following the same general principles that are employed in dealing with the questions in regard to other manufacturing tools, we will find it a simple problem. As was stated before, the whole subject is covered by the first page of this paper.

EARLE BUCKINGHAM,
*Captain, Ord. Dept., U. S. R.,*
*Gage Manager,*
and
G. F. MATTESON.

## The Dake Steam Turbine

TO THE EDITOR:

I have read with great interest the paper on Commercial Analysis of the Small Steam Turbine Situation, by W. J. A. London, as published in THE JOURNAL for December 1917.

I note that in enumerating the various types and makes of steam turbines, the statement is made that the Bliss, Dake and Wilkinson turbines are either no longer on the market or are not seriously competitive. I wish to correct this statement, which may have arisen from the fact that the Dake turbine is no longer manufactured by the Dake American Steam Turbine Company, of Grand Rapids, Mich., this company having gone out of business.

The Dake turbines are now being manufactured by the Pyle-National Company, Chicago, Ill., and there have been built and are in successful operation 22,300 of them, aggregating some 70,000 hp. These turbines are of the single-stage impulse type made under my patents, and substantially all of them are used in connection with turbo-generator units. More than 80 per cent of the electric headlights in operation on steam locomotives today are driven by turbo-generators manufactured under the Dake patents.

CHARLES W. DAKE.

Chicago, Ill.

# SOCIETY AFFAIRS

## A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE minutes of the January meeting of the Council, published elsewhere in this number, record the transactions of several items of business which will have an important bearing on the Society's activities during the coming year, and which I am glad to comment upon, particularly in reference to the committee appointments by President Main, which are a controlling factor in the management of the Society.

On the Finance Committee, Theodore Stebbins, consulting engineer of New York City, has been appointed in place of W. H. Marshall, resigned. Mr. Stebbins has previously served on the Membership Committee of the Society, and has specialized of late years in the financial features of engineering undertakings.

Mr. Robert M. Dixon, Chairman of the Finance Committee, whose term of office had just expired, was reappointed. During the past few years the Society has been more fortunate than its members realize in the sound financial administration and progressive business policies its Finance Committee has maintained. Since Mr. Dixon became Chairman of the committee in 1911, the membership of the Society has increased from 4000 to nearly 9000, and the total annual income from $97,600 to $207,000. In 1911 the Society owed $81,000, but had, besides its investment in the Engineering Societies Building, $20,000 in cash and bonds, and trust funds amounting to $42,000. At the present time it is owing nothing, has equity in the enlarged Engineering Societies Building, and has cash and bonds amounting to $130,000, utilized in trust funds and working capital.

During this period the Finance Committee has consistently held to the policy of allowing for the annual budget only 90 per cent of the estimated income, reserving 10 per cent to insure an annual contribution to the reserve fund to guard against contingencies. Its chairman has also advocated and stood back of the effective work of the Increase of Membership Committee whereby the membership of the Society has been more than doubled, and at the same time the average professional standing of membership has been raised. The initiation fees were formerly used to retire the certificates of indebtedness of the land fund, resulting in the cancellation of this indebtedness last July, which must be regarded as a remarkable record. At the present time 50 per cent of the initiation fees are placed in reserve and the balance is available for current expenses.

This brief statement shows the sound financial condition of the Society and the debt which its members owe to the foresight and ability of its Finance Committee and its able chairman, whom Mr. Main has so fortunately prevailed upon to continue on the committee.

Many committees of the Society have lost valued members because of their entering the service of the Government. In the case of the Committee on Meetings, John H. Barr left for that purpose, and J. W. Upp of Schenectady, who took an active part in the interesting session on the Woman Worker at the last Annual Meeting, was appointed in his place. The regular appointee to the Committee is W. G. Starkweather of Boston, Mass., whose work as Secretary of the Boston Section is widely known and appreciated.

While the requirements of the Committee on Meetings are such that frequent meetings must be held, necessitating residence within easy reach of New York, the effort has been made to secure a committee as widely representative as conditions will permit, and its members now come from the cities of Schenectady and Ithaca, New York; Elizabeth, N. J.; Boston, Mass., and one from New York City. Prof. Robt. H. Fernald, of Philadelphia, is the retiring chairman, and the last Annual Meeting and the Spring Meeting at Cincinnati, which came under his direction, have been generally regarded as the most successful and enthusiastic conventions which the Society has held.

On the Publication Committee two new appointments were required because of war conditions. These are George A. Orrok, formerly mechanical engineer for the New York Edison Company, and now consulting engineer with an office in New York, who has for many years been a student of engineering periodicals; and H. H. Esselstyn of Detroit, Mich. In the appointment of Mr. Esselstyn, there is brought to the Publication Committee one who represents the viewpoint of our members of the Middle West, to whom the Society's publications should be of increasing importance, forming as they do the main connecting link between such members and the various sections throughout the country, including New York. Mr. F. R. Low, who has been chairman for the past five years and a member for part of a previous term, because of his intimate acquaintance with publishing and his sound judgment in such matters, has been a most valued member. The regular appointee on the committee is Ralph E. Flanders, who has had publication experience on *Machinery*, and is now general manager of the Jones and Lamson Machine Company, Springfield, Vt.

On the Public Relations Committee the new appointee is J. Waldo Smith, chief engineer of the Board of Water Supply, New York City, who has been identified with important public-works construction for many years.

Of all the committees of the Society, none has more arduous duties nor requires more conscientious effort than the Membership Committee, on which W. S. Timmis is the appointee. The Society has sustained a sad loss in the death of the former chairman of the committee, L. R. Pomeroy, whose place was temporarily filled during part of the past year by James W. Nelson, with Hosea Webster as acting chairman. Mr. Timmis is a consulting engineer in New York and has specialized on printing machinery and the construction and equipment of printing plants. Incidentally he was consultant for the large plant where THE JOURNAL is now printed.

On the Library Committee, John W. Lieb, who retires, has been succeeded by W. N. Best, President of the W. N. Best Company, Inc., New York. This committee has the duty of serving on the Library Board, administering the Joint Libraries of the four Founder Societies. The annual report of the Board appears in this number.

The House Committee, which is responsible for the maintenance of the Society's headquarters and for its homelike surroundings, has as its new appointee J. D. Maguire, President

of the Maguire Rubber Company, of New York. He succeeds Fred. A. Scheffler, who has contributed generously of his time both in connection with the House Committee and in providing for the pleasure of visitors at the annual meeting.

To the Research Committee has been added one of the strongest men in the department of research in the vicinity of New York, Prof. Walter Rautenstrauch of Columbia University, who succeeds Ralph D. Mershon. It is believed by many that the Research Committee affords the greatest opportunity in the Society for useful service, through the coödination and development of research work in colleges and among the industries. At present, the Research Committee has several sub-committees engaged upon important investigations.

Prof. Frederick R. Hutton was reappointed to the Constitution and By-Laws Committee, where his intimate knowledge of the history and precedents of the Society are invaluable. Professor Hutton of this committee and Mr. Dixon of the Finance Committee are the two members of Standing Committees who received reappointments. The President in making appointments tried, so far as is possible, to distribute them among the membership at a distance from headquarters for the obvious reason of bringing members in touch with the Society.

The Standardization Committee acts as a coördinating committee to direct and unify the standardization work conducted by the several special committees of the Society. Two new members were appointed: Prof. L. S. Marks of Harvard University and Massachusetts Institute of Technology, the author and compiler of the Mechanical Engineers' Handbook and at present engaged upon expert work for the Government in connection with engines and carburetors for aeroplanes; and C. F. Hirshfeld of the research department of the Detroit Edison Company.

Of perhaps greater importance than the personnel of our present committees was the preliminary action taken at the Council meeting, at the suggestion of President Main, looking toward the adoption as a fixed policy of the Society of the plan carried out under the administrations of Dr. Jacobus and Dr. Hollis for nominating the Society's officers. This plan is entirely democratic in that the Nominating Committee is made up of representatives from the various sections or groups of sections throughout the country. The Local Sections Committee of the Society has been asked by the Council to formulate rules for incorporating this plan into the Constitution and By-Laws, thus making it a fixed policy to nominate officers through representatives who actually represent the widely distributed membership. This is a policy which has been carried out by the American Society of Civil Engineers.

CALVIN W. RICE, Secretary.

# COUNCIL NOTES

A REGULAR meeting of the Council was held in the Engineering Societies Building on January 18, beginning at 11 a. m. and continuing throughout the afternoon. There were present Charles T. Main, *President;* *Past-Presidents* Ambrose Swasey, D. S. Jacobus, John A. Brashear, W. F. M. Goss, F. R. Hutton; Wm. H. Wiley, *Treasurer;* Robert H. Fernald, D. R. Yarnall, John Hunter, H. de B. Parsons, Fred N. Bushnell, R. M. Dixon, *Chairman Finance Committee;* Calvin W. Rice, *Secretary;* F. R. Low, *Chairman Publication Committee;* and by invitation, Dr. C. R. Mann of the Carnegie Foundation and Mr. E. J. Mehren, Editor of the *Engineering News-Record.*

*Committee Appointments:* The President announced the following appointments to standing and special committees:

*Finance,* Theo. Stebbins, one year, R. M. Dixon, five years (reappointment); *Meetings,* J. W. Upp, one year, W. G. Starkweather, five years; *Publication,* George A. Orrok, one year, H. H. Esselstyn, three years, Ralph E. Flanders, five years; *Public Relations,* J. Waldo Smith; *Membership,* W. S. Timmis; *Library,* W. N. Best; *House,* J. D. Maguire; *Research,* Walter Rautenstrauch; *Constitution and By-Laws,* F. R. Hutton (reappointment); *Standardization,* L. S. Marks, two years, C. F. Hirshfeld, five years; *Sections,* H. B. Sargent.

*Nominating Committee.* Action was taken toward continuing permanently the custom inaugurated during the presidential terms of Dr. Jacobus and Dr. Hollis of appointing as a nominating committee for officers representatives selected by the various Local Sections, arranged in groups for this purpose. The following resolution was passed:

*Voted:* That the Sections' Committee as a special committee of the Council, with Mr. Yarnall as chairman, be requested to report to the Council suggestions of procedure whereby the Nominating Committee may be regularly chosen through the nomination by sectional groups of the Society along lines similar to those of the American Society of Civil Engineers, and in accord with the custom of the Society for two years.

*Annual Meeting Resolutions.* As recorded in THE JOURNAL for January, resolutions were passed at the Annual Meeting and referred to the Council: (1) A resolution at the business meeting providing for a committee to investigate opportunities for coöperation between the Government and the technical schools in the training of men for service in the War and Navy Departments. (2) A resolution introduced by Sir Charles Ross at the Machine Shop Session calling for a board to be intermediary between manufacturers and inspectors, and the Secretaries of War and the Navy, to hear complaints and give advice; (THE JOURNAL, Jan. 1918, p. 67). (3) A resolution adopted at the Gage Meeting asking for the certification of all master and reference gages, and standards of measurements, where so required, by the Bureau of Standards as the official agency for the purpose. (THE JOURNAL, Jan. 1918.)

In respect to these, (1) the Council directed the appointment of a committee; (2) a letter was read from the Secretary of War expressing appreciation of the Society's helpfulness and stating that it was planned to take up at once the suggestion of an intermediary board; (3) the Council approved and referred the resolution back to the Gage Committee to take up with the various Bureaus of the Government, and also asked the Secretary to present it to the Engineering Council.

*Standardization of Bolts and Nuts.* In response to a request for standardization by Mr. C. B. Auel, it was voted that the Engineering Council be requested to consider the advisability of placing under the Engineering Council all standardization committeees of the four societies to deal with standards wherein two or more societies are interested.

*Engineering Education.* Dr. C. R. Mann, of the Carnegie Foundation, brought to the attention of the Council the proposed plan of the Federal Board of Vocational Education to divert the Engineering Colleges of the country for a period of five months from their regular work of training engineers

to the training of technicians for the war. Resolutions were passed expressing the opinion that such a step was unwise at this time.

*Amendment to By-Law 16.* Voted to approve the following revision of B16:

B16*a* The Council may in its discretion restore to membership any person dropped from the rolls for non-payment of dues or otherwise upon such terms and conditions as it may at the time deem best for the interests of the Society.

B16*b* The Council may in its discretion remit the dues of any member of the Society in any grade who is engaged in military or other patriotic service of the United States during the continuance of the war conditions and for a period thereafter.

B16*c* The Council shall permanently exempt from dues any member of the Society who has paid dues for thirty-five years or who shall have reached the age of seventy years after having paid dues for thirty years.

*Boiler Code Interpretations.* The record of Boiler Code Interpretations covering Cases 181 to 184 were approved and ordered published in THE JOURNAL. They appear elsewhere in this issue.

*Membership Badges.* On recommendation of the Membership Committee, a smaller size of badge was approved for those who prefer it to the larger badge now exclusively used.

*Members in Military Service.* It was voted that members who have honored the Society by entering the military service of the United States shall receive all privileges of their membership and have their current dues remitted upon request.

*Printing of Reports.* Printing was authorized of the preliminary report of the Committee on Tolerances in Screw Thread Fits; the report of the Committee on Weights and Measures; and three preliminary reports by sub-committees of the Research Committee, covering Flow Meters, Bearing Metals, and Lubrication.

*Employment Work.* In view of the extensive growth of the employment work of the Society, which has been conducted under the personal supervision of the Secretary, it was voted that this activity now be assigned to a committee for its direction, and it was suggested that the work be combined under the same committee with that of the Engineering Resources Committee, which now is supervising the work of supplying engineers for Government service.

*Isherwood Bust.* The Council accepted with deep appreciation the gift from Miss Isherwood of a pedestal for the bust of Admiral Benjamin F. Isherwood, which was presented to the Society at its Annual Meeting.

*Appointments.* The following committee and other appointments were authorized:

*Engineering Council.* Charles T. Main was appointed a member for one year in place of Arthur M. Greene, Jr., resigned.

*Worcester Section.* On recommendation of the Sections Committee for officers of the Worcester Section: George I. Rockwood, *Chairman;* H. P. Fairfield, *Secretary;* W. W. Bird, W. H. Damon, George N. Jeppson, F. W. Parks.

*Fuel and Fuel Conservation.* As a representative on the Advisory Committee on Fuels to the Bureau of Mines, O. P. Hood.

*Washington Award.* In response to a request from the Western Society of Engineers for representatives to serve on its Board of Washington Award for Engineering Achievement: M. E. Cooley for one year and Charles Whiting Baker for two years.

*Junior Prize Committee.* A. L. DeLeeuw, *Chairman;* J. A. Brooks and George B. Brand.

*Student Prize Committee.* George B. Haven, *Chairman;* F. R. Hutton and William Kavanaugh.

*Machine Shop Practice Committee.* Ralph E. Flanders, *Chairman,* for one year, and George Langen, Henry Spencer and William A. Viall for five years.

*Tellers of Election.* R. F. Jacobus, *Chairman;* Norman G. Reinicker, Claude Hartford.

CALVIN W. RICE, *Secretary.*

# THE PRESS ON THE WAR CONVENTION OF THE SOCIETY

AMERICA is just now beginning to mobilize her engineers so that the present world war may be the last great war. And in the light of this mobilization the thirty-eighth Annual Meeting of The American Society of Mechanical Engineers assumes extraordinary interest. Thus the *Iron Trade Review* strikingly characterized the Society's war convention, and it is a matter of gratification to report that the magnificent spirit of patriotism and public service that ran through its many sessions was similarly recognized in every other press notice. The *Engineering News-Record* commented upon the timely addresses that "dealt with the manifold and vital relation of the engineering profession to war-supply requirements." The *Evening Sun* of New York gave full credit to the hundreds of mechanical experts who have been sacrificing their time and money in war work and who quietly and unostentatiously have aligned themselves in a solid phalanx behind the Government.

The above press comments are only reflections of the general attitude that is now being taken toward the engineer. It is becoming more and more evident that in these days of war the engineer must come out of his "technical shell," must become a citizen of the world ready to bear the great economic and social burdens that of necessity will have to be placed upon his shoulders. The troops are fighting valiantly at the front; behind them are the great national executive organizations that direct their movements. But behind both are the engineers—the engineers in all fields—whose thoughts and skill are constantly changing the state of peace and war. Through many of the press reports there runs this undercurrent of thought: the present condition of affairs seems to indicate that the engineers have used their power only to unloosen the great destructive forces that are spreading havoc and misery broadcast. It is for them to vindicate themselves; to allow their power, their skill and the great store of knowledge at their command to run into constructive channels so that the great forces of science will be used for man and not against man, and so that the civilization of the world that has been built up so slowly and so laboriously during the long centuries of man's existence on the earth shall not perish.

The Society is well aware that just at present the need of diverting engineering into more beneficial channels should occupy the minds of all thoughtful and farsighted men, and that the mechanical-engineering field should and must be so broadened as to be able to include the great economic and industrial problems of both today and of the future.

*Forbes' Magazine* says of the meeting: "Human engineering is but one of the many phases of the mechanical engineer's

broadened field in an age when the direction of industry is more and more passing to the hands of 'masters of material,' represented by the industrial engineer whose business it is to provide both management and workmen with scientific industrial methods and accurate records of production." And in accord with this development of the field of mechanical engineering the Society held its session on Management and invited surgeons, Government officials, Red Cross directors, psychologists, psycopaths, social workers and others to coöperate in putting back upon the payroll of the world both the war cripple and the industrial cripple and thus make of them useful and independent members of the state instead of objects of charity. Not only must the existing labor supply be improved and rehabilitated, but a new supply must be added in such a way that our production and distribution in the future will be allowed to reach the maximum point of efficiency; and thus at another session of the convention the question of the employment of women in the skilled industries was considered from a mechanical as well as a psychological standpoint.

The conservation of time and energy, of food and fuel, is a matter of the most vital importance both at home and abroad. The press had only words of praise for the Society's recognition of this fact and for its inclusion in its keynote session a consideration of the problems of conservation that the Government with the aid of the engineer is attempting to solve today.

There was hardly an account that did not contain at least one extract from Dr. Hollis's address on Universal Service in Peace and War. The assertion of Professor Kimball that "mechanical engineering would soon include every subject in the world and that the aims of the Society ought to be therefore redefined," was another favorite point for press comment.

The fuel situation as outlined by Professor Breckenridge was the subject for much discussion and speculation, and the statistics given by Mr. Myers in his paper on Preventable Waste of Coal in the United States must have touched a vital chord in the fuel question, for they were quoted again and again.

The conservation of energy and time as treated by Mr. Gregg, Mr. Gantt and others, was heartily endorsed by the daily as well as the technical press. Special attention was directed to the fact that not only were the timely subjects of transportation, airplane building, cantonment construction given to the assembled engineers for consideration but for solution as well, and the *Iron Trade Review* predicted that "undoubtedly the convention will show fruitful results in coming months."

As was expected, the valuable contributions along strictly technical lines which ordinarily attract so much attention were relegated to a second place by the war subjects. But this is only corroboration of the fact that the country's needs during the war crisis dominated the whole convention so strongly and so potently, and that so far as the mechanical engineers of the country, as represented in our membership, are concerned, there is from now on only one task.

## Junior and Student Prizes

THE rules covering the awards of Junior and Student Prizes for technical papers have been made more comprehensive this year in that a definite standard has been established by which the papers are to be judged. According to this new standard, the prizes will be awarded for the best papers adjudged from the standpoints of originality of matter, applicability (practical or theoretical), value as a contribution to mechanical-engineering literature, logical development of contents, conclusiveness, completeness and conciseness. These specifications, besides furnishing the examining committees with a definite basis upon which to rate the papers submitted, will also serve to assist competitors in the preparation of their manuscripts.

As to suggestions for topics of papers, besides the usual specific technical subjects, of which there are a large variety in every branch of the profession, papers dealing with how the engineer can be of service in these days of war are this year in order. In this latter connection papers might well be written on such topics as the following:

Laboratories for war testing, including munitions; organization for war research with special reference to munitions and fuel; industrial reconstruction plants to meet the needs of war industries; application of management systems to war plants; records of cost of operating war plants; novel methods of training and managing employees in war plants; workmanship requirements; safety devices and measures for men and women workers; new buildings for housing munitions plants; speed of production in munitions plants; maintaining efficiency of machines used in continuous production; specifications covering munitions requirements; certification of munitions gages; standards and interchangeability in munitions parts; machine-shop practice and inspection in wartime; increased terminal facilities in wartime; new responsibilities of the engineer in wartime, etc.

From the technical standpoint a paper might well be devoted to any one of the following subjects: a description of a new mechanical invention or piece of enginering apparatus; an account of some original work in the laboratory, shop or classroom; a description of a novel modification to an existing plant; an explanation of plans or methods of proposed engineering work; a summary of present practice in a given mechanical field or an argument for or against a particular mechanical apparatus, process, construction, etc.

The prizes themselves and the certificates accompanying them are both inducements to Junior Members and to members of Student Branches to enter these annual competitions. Added incentives are the opportunities furnished by the Meetings Committee and the Publication Committee of considering successful papers for presentation at the meetings of the Society and inclusion in its publications.

The rules covering the award of these prizes are given in the Year Book of the Society, the 1918 edition of which is about to be issued. The last date for submitting papers for consideration by the Committee on Awards this year is June 30. Any other information desired by those who intend to compete will be gladly furnished by the Secretary.

## Activities of the A.S.C.E. During the Past Twenty-five Years

AT the December 5, 1917, meeting of the American Society of Civil Engineers, Mr. Charles Warren Hunt, secretary, presented a review of the activities of the society during the past twenty-five years. While devoted fundamentally to the work of the organization, Mr. Hunt has served for even longer than the period it covers. The paper contains sections of particular interest to our Society as a Founder Society and as a sister organization with similar objects and aims.

Mr. Hunt thus adequately sums up the functions of a national technical society:

1 To advance engineering knowledge and practice

2 To maintain the dignity and standing of the organization,

and to preserve the high character and professional qualifications of its membership

3 To keep in touch with, and take proper action on, all matters in which the relation of the profession to the public is involved, and to render service to the nation when occasion demands

4 To do whatever is possible for its members individually, and, in general, to return to them an equivalent for the dues paid.

"The latter function necessarily takes the form of providing opportunity for professional discussion, both formal and informal, which, as in the case of this society, more than 80 per cent of the membership is non-resident, must be through publications."

This latter statement by Mr. Hunt applies with equal significance to our own Society, since, like the Civil Engineers, we have a non-resident membership of 80 per cent. One modification could be applied to the statement with justification, however, and that is that 86 per cent of our membership is included in the Local Sections, an activity which has disclosed tremendous possibilities, many of which, due to the good generalship of our present Committee on Local Sections, are about to be realized. This is as it should be, for whether a society's membership is resident or non-resident, all members should have equal benefits from all the activities—meetings, publications, library, etc.

Another significant paragraph of Mr. Hunt's paper is that devoted to war activities. This applies equally to all the societies, and much of the work in this connection which Mr. Hunt describes has been done jointly by all the societies working together. One unique contribution that the Civil Engineers have made, and for which they should be granted full recognition, is the offering of their former headquarters to the United States Food Administration as a central office for its work in New York State. This offer was made unqualifiedly and was gladly accepted by the Board.

Other sections of Mr. Hunt's paper describe the removal of the Society to its new headquarters in the Engineering Societies Building and show plans of the new rooms, describe the tremendous work of transfering their library, which consisted of 89,000 accessions, of which 67,000 were not duplicated in the libraries of the Founder Societies, gives a history of the local sections, meetings, publications, special committees, and other activities of the Society.

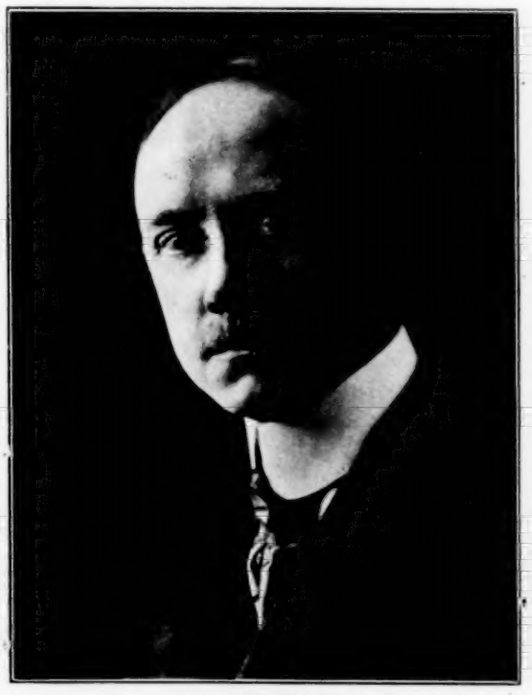
To the report is appended a classification of the library of the Civil Engineers, in which work Mr. Hunt has always evinced a keen interest and which he brought up to a remarkable degree of perfection.

# SECRETARY OF COOPERATIVE ACTIVITIES

## Appointment of Mr. Alfred D. Flinn to the Secretaryship of the Engineering Council, the Engineering Foundation and the United Engineering Society

ALMOST significant step is the appointment of Mr. Alfred D. Flinn, Member of the American Society of Civil Engineers, to the secretaryships of the Engineering Council, the Engineering Foundation and the United Engineering Society. Such an appointment indicates that the necessity for concerted action in all matters pertaining to the engineering profession has been fully realized and that the professional solidarity that has long been the goal of engineers of vision is at the point of consummation.

To Mr. Flinn is given a great task—a task ably begun by the Engineering Council through its Committee on Public Affairs, its War Committee of Technical Societies and through its individual members. Mr. Flinn is worthy of the task; his broad executive and organizing experience and his great skill in securing the hearty coöperation of all his coworkers will stand him in good stead in his endeavor to make of the engineering profession a united profession of service to all mankind. A brief sketch of his achievements and attainments follows:



ALFRED D. FLINN Underwood & Underwood

ALFRED DOUGLAS FLINN

Alfred Douglas Flinn was born in New Berlin, Union County, Pa., August 4, 1869. He was graduated from the Worcester Polytechnic Institute in June 1893 and immediately afterward went to Boston. His first engagement was with the firm of George S. Rice and George E. Evans, consulting engineers, on surveys for the so-called "alley route" for a proposed elevated railway through the heart of Boston, and on surveys for the Muddy River Parkway. In November, 1893, he obtained employment on the Boston Water Works under Dexter Brackett, engineer of the distribution department, and was engaged upon upkeep, operating and construction duties and extensive tests of fire-department apparatus until the spring of 1895, when he entered the engineering office of the Associated Factory Mutual Insurance Companies under John R. Freeman. Here he was engaged for a few months upon hydraulic experiments and factory surveys.

In July, 1895, upon receiving an offer from Dexter Brackett, Mr. Flinn became connected as transitman with the distribution department of the engineering force then being organized by Frederic P. Stearns as chief engineer of the Metropolitan Water Works for the Boston metropolitan district. He had an active part in the creation of this organization and in the surveys, investigations, designs and construction, rising

through various ranks until early in 1900, when he was made principal office assistant in the Boston office, charged with the preparation of contracts and drawings, investigations and miscellaneous office work. This system included the well-known Wachusett dam and the Wachusett and Weston aqueducts, together with large distributing reservoirs, pumping stations and pipe lines in Boston and the surrounding municipalities. During the winters of 1900-01 and 1901-02 Mr. Flinn gave a course of lectures to senior classes of the Lawrence Scientific School, Harvard University, on water supply and sewerage.

In October, 1902, Mr. Flinn was asked to become managing editor of the *Engineering Record* and removed to New York to take up these new duties. Shortly thereafter the *Engineering Record* was purchased by the McGraw Publishing Company and increased in size and scope. In August, 1904, he left the *Engineering Record* to become general engineering inspector of the Croton Aqueduct Commissioners under J. Waldo Smith, Chief Engineer, and remained for a year in that office. During the year he had charge of the completion of designs for the new Croton dam and Jerome Park reservoir, prepared designs and contracts for the Cross River reservoir and began those for the Croton Falls reservoir, all of these works being parts of the Croton water-supply system of New York City.

During the summer of 1905 the Board of Water Supply of the City of New York was created under special legislation and Mr. J. Waldo Smith was engaged as chief engineer. Mr. Flinn became the first member of Mr. Smith's staff and with him had a large share in the creation of the engineering organization which later earned an enviable reputation for its effectiveness, business-like methods and *esprit de corps*. Until August, 1914, Mr. Flinn was department engineer of headquarters department, in charge of civil-service matters, special investigations, designs, preparation of contracts and reports, inspection of materials, and requisitioning of supplies and equipment for this large organization. August 1, 1914, Mr. Flinn became deputy chief engineer and so remained until he assumed the duties of secretary for the United Engineering Society, the Engineering Foundation, and Engineering Council. The Catskill Mountain water system for providing 500 million gallons daily additional supply of water for New York City, including the Catskill aqueduct, the Ashokan and Kensico reservoirs and other important works, are so well known as to require no detailed description in this brief account of Mr. Flinn's professional career.

From an early period in his engineering work Mr. Flinn has been a frequent contributor to engineering literature, on a variety of subjects, and is one of the compilers of the Water-Works Handbook, in the preparation of which Mr. Robert Spurr Weston, of Boston, and Mr. Clinton L. Bogert, of New York, were associated. This book has been adopted by the U. S. Army Engineers.

## Members' Pins and Certificates

A slight increase has been made in the prices of pins and certificates supplied to members of the Society. The new schedule of prices is:

Dark blue enamel four-leaf clover official badge, with letters in bright gold, for honorary-members, members, associates and associate-members:

| | |
|---|---|
| Pin | $4.00 |
| Charm | 5.50 |
| Stick-pin | 4.00 |
| Button | 5.00 |

Crimson enamel four-leaf clover official badge, with letters in bright gold, for junior members:

Prices same as above.

Membership certificates, all grades, including engrossing ..... $1.50

A small pin, one-quarter of the size of the present pin, can now be obtained, price $3.00, screw back. It will probably be some time before a complete stock of these pins is on hand, but orders will be placed on file and will be filled as early as possible.

# AMONG THE LOCAL SECTIONS

A NEW era in the history of the Local Sections was begun at the Local Sections Conference, held on Tuesday, December 4, during the Annual Meeting of the Society. Mr. D. Robert Yarnall, Chairman of the Committee on Sections, presided and a report on the new By-Laws governing Sections was presented by Prof. L. C. Marburg, member of the Local Sections Committee. Delegates representing twenty out of the twenty-one Sections were in attendance—the largest proportion ever present at a general meeting. In addition there were representatives from four branches of the Connecticut Section, as well as visitors from centers of the country interested in the formation of sections.

The conference was divided into two parts; first, a luncheon, at which the Sections delegates had an opportunity to meet informally the members of the Council, and second, a business meeting. The latter was arranged to develop four topics of importance to all the Sections at this time: 1. The new By-Laws and the Sections. 2. Coöperation between Sections and other local societies. 3. How the Sections can secure papers. 4. The Sections and research.

The first of these topics was ably presented by Prof. L. C. Marburg, member of the Committee on Local Sections, in the form of a paper which will be given in full in the next issue of THE JOURNAL. The other topics were developed in the form of informal discussion, an account of which follows.

### DISCUSSION AT THE CONFERENCE

#### COÖPERATION BETWEEN SECTIONS AND OTHER SOCIETIES

PROFESSOR RAUTENSTRAUCH (Sections Committee): The Committee on Sections has been very much interested in the work of the different Sections in coöperating with the local engineering organizations. We find that the Sections in St. Louis, Milwaukee, Chicago and Detroit, which we visited about a month ago, are working toward a better coöperation on the part of the local engineering organizations with our national Society, and these visits have been sources of inspiration and encouragement to us, and we hope that during the coming year we may have an opportunity to visit other Sections and become acquainted with the work which is going on.

It is almost impossible to maintain a separate and distinct organization in any community without coöperating with the local sections or branches of other national organizations and local engineering organizations that are in the community. Where there is an engineers' club we find that it is inevitably the case that our Local Section, together with other local sections of the other national organizations, group about the engineers' club or engineers' society as a focal point. In Birmingham, where there is no engineers' club, the Alabama Technical Society was formed

and membership in that society is limited to those who are members of the local sections of national organizations. Thus there seems to be a demand for some centralizing element or influence that the different engineering organizations may group about, and it is only through the coöperation of the local societies in this way that I think we can grow both as Sections and as a national organization.

MR. ENGEL (Chicago): We have the Western Society of Engineers in Chicago—a general engineering body, composed mainly of civil engineers, with some electrical engineers and mechanical engineers among its membership. They offered us various encouragements to meet with them. At first we had an idea that the mechanical engineers would not gain very much by an affiliation with them. The Sections Committee gave us a different viewpoint, and we are going to meet with them now, and be one with them. We have coöperated with the other engineers in the formation of a Citizens' Unit, and also in the formation of the whole of the First Illinois Regiment of Engineers.

It has been my own conception, as I have viewed the problems in Chicago, which is the second city in America—a city which in some respects is more the center of the country, and more the center of industry than New York—that the close and cordial coöperation of all of the engineering organizations in that city may ultimately bring about the erection of a second engineering headquarters, which, to many of us, would be of more value, perhaps, than the building in New York.

The first step, however, in doing big things is real coöperation between the engineers, and that has been the propaganda that the Committee on Sections has been carrying on. The engineers must combine their purely local questions with a view to promoting the general welfare of the profession as a whole, while at the same time maintaining a certain individuality in order that the technical interests of a particular profession will be taken care of. In this building we have a bringing together of all of the national engineering societies. It is a kind of affiliation, a coöperation which could easily be brought about in Chicago.

MR. RADCLIFFE (St. Louis): We have been coöperating with the local sections of the national societies in St. Louis for many years. It came about very largely as the result of an agreement entered into by the local society a number of years ago to the effect that each section of a national society should present not less than two papers each year at a meeting to which members of the other local organizations in St. Louis would be invited. This has helped us to secure good papers, and we have been assured of at least six meetings a year. The organization is called the Associated Engineering Societies of St. Louis.

There is a point that it might be well to emphasize, and that is in making your arrangements for coöperating with the local sections of the various national societies, do not lose your own identity. We have avoided that this year by planning a definite program, with one monthly meeting of the Local Section of the A.S.M.E. from September to May, and we hold that meeting regardless of the two joint meetings which the A.S.M.E. is responsible for as members of the Associated Engineering Societies of St. Louis, which may be given any time of the year.

MR. HOENTER (Detroit): We have the Detroit Engineering Society, an organization which has about six hundred members. The mechanicals, civils, architects and automotive engineers are particularly strong in the city, and the Detroit Engineering Society has taken it upon itself to provide speakers, representing the various organizations. The individual societies might ordinarily get out as many as twenty-five men to a meeting, which is rather discouraging for a speaker with a national reputation, whereas if the Detroit Engineering Society brings him to the city, we are assured of an audience which fills the hall to capacity.

PROFESSOR FAIRFIELD (Worcester): "What has the Section done to coöperate with the profession at large?" In Worcester there are no prominent engineering societies. We are strictly an industrial city, and we have a technical school of some note. We seemed to find that the Boston Section appealed to a considerable number of us, but that as far as the industries went it did not attract them. When the members of the Society began to consider the fact that Worcester was to be given a chance to have the President of this great Society, we began to discuss the question to see if we could not have the A.S.M.E. coöperating with the industries in such a way as to interest those men who are prominent in the industries, largely in machine-tool building and similar industries. We also have a considerable alumni of the Worcester Polytechnic Institute, located in the city and near it, many of them connected with the industries, so that the Worcester Section instead of coöperating with other sections of other societies, undertook to coöperate with the industries and with the Alumni of the Worcester Polytechnic Institute, and to bring the student body also in contact with the A.S.M.E. This is a good form of coöperation to be considered in many of these smaller cities. It can be done well where a city is the central or focusing point of a number of towns.

MR. GEIER (Cincinnati): We have formed in Cincinnati a joint association of electrical and civil engineers called the Engineers' Club. We have meetings once a month and after every meeting we have refreshments, at a series of small tables seating four to six persons. In that way the men present get thoroughly acquainted with each other. We have ten meetings a year, and out of the ten meetings we undoubtedly have eight at which the papers are of such a character as to bring out an attendance of 200 members or more.

Many of the professors of the University of Cincinnati are members of the club and it seems to be an excellent thing to bring these professors into contact with the practical men who are doing the work in the field of industry, and it is having its effect on teaching in the engineering colleges. There are many places in the United States where the same conditions prevail and we ought to make a strong effort to bring into our Society the members of the different engineering colleges and schools. It is very helpful to the practical men of affairs to have the students and the professors at their meetings—it broadens their viewpoint. In Cincinnati we are getting something of that bigger outlook and vision which Mr. Marburg has so well spoken of.

MR. KLINCK (Birmingham): The Alabama Technical Association is a result of coöperation. Membership in the Alabama Technical Association can only be held by men who are members of one of the national organizations which have representatives in the city, the mechanical engineers, electrical engineers, the mining engineers, the chemical engineers and the architects. Where those societies have the ordinary membership, the men in college can come in. We are going to make the Alabama Technical Association stand for something in the state, not only along engineering lines, but as a public-service proposition.

PROFESSOR RAUTENSTRAUCH: In order to successfully carry out coöperation, there must be some definite objective as the basis upon which coöperation can be made. One can have social coöperation, coöperation in organization, coöperation in the technical papers and technical meetings, etc. Thus each section should definitely find the objective for the year on the basis of which coöperation shall be carried out. Coöperation is a rather fascinating term, but if it is allowed to stand in the air, there will be no particular element about which there can be crystallization of effort. We as engineers are organizers, and it should be a simple problem for each Section to study its local conditions and then go ahead and appoint as committees in charge of the matter those who will be able to bring about the necessary influences to get the work and the objective clearly defined.

### HOW THE SECTIONS CAN SECURE PAPERS

PROFESSOR RICHARDS (Sections Committee): Last July the Chairman of the Committee on Sections addressed a letter to each of the Local Chairmen. Part of the letter reads as follows:

"The Committee on Sections recognizes that the Sections emphasize the national scope of the Society, and through them membership is made of greater value to each individual.

"Next in importance to the work of the Sections is the development of THE JOURNAL and TRANSACTIONS, and the Sections are expected to perform a real service in this essential. As engineers, we know that only through organization and by having certain individuals charged with a definite responsibility can an objective be accomplished.

"In a Society as large as ours, the personal element is largely developed through the point of contact between member and Local Section and it is evident that if the best publication is to be issued, it must be supported by the active interest and work of the Sections. THE JOURNAL should contain each year at least *two* technical papers of live interest from each of the Sections. Take for instance the paper by W. P. Barba on Industrial Safety and Principles of Management, presented before the Philadelphia Section, December 1915, which was considered of so much interest that it not only was published in THE JOURNAL, but was later selected for presentation at the 1916 Annual Meeting. See the yellow pages in the July 1916 JOURNAL for other examples.

"If these facts were generally known to the individual members of Sections, we believe members would submit more papers to the Society.

"The Committee on Sections therefore suggests as a uniform practice that each Local Section make a special effort this year to contribute technical papers and data, through the establishment of the following organization:

"Appoint a committee of three, particularly qualified, to study the local field, determine what papers and data your Section is best qualified to contribute, solicit the contributions of papers from your local engineers and report to the Committee on Sections. We would call attention to the fact that these papers need not be long. In fact, brief, concise statements of valuable information often are of equal interest and value to longer papers.

"Appoint a committee of two, qualified by broadness of vision to investigate what researches may be most effectively carried out because of the particular engineering work being done in the locality. Men who are particularly fitted to organize and conduct these researches and report the findings to the Committee on Sections should be appointed."

The Committee on Sections felt that it was particularly important to have a Committee on Papers organized in each Section and that the committee be charged with the work of stimulating the members in the preparation of papers of merit. The papers should not be mere verbal discussions, but should be prepared in a somewhat formal way so that they may be discussed formally, and so that they may be presented to the Committee on Meetings as possible material for publication in the TRANSACTIONS, and for presentation at some of the meetings of the national Society.

It has often been stated that we get out of an organization just exactly what we put in it, and that is a thing we must keep constantly before us. We will get out of this Society just exactly what we put into it and one of the things that each of us should feel desirous of putting into it is a contribution, from time to time, of the things we know about and are interested in as engineers and are competent to discuss. It is an unfortunate commentary on this country that there are no technical publications, outside of the journals and transactions of the national engineering societies, which are really engineering periodicals. We have a host of trade papers, but no engineering publications like the London *Engineer*, the *Zeitschrift*, or the *Revue de Mécanique*. Very few of the national engineering periodicals will publish an article which has a differential sign or an integral sign. Outside of a publication such as our JOURNAL, there is no place where real contributions to the literature of engineering are made, except as they are presented in semi-popular form and reflect the immediate engineering of the time. In expressing the Committee's views, I am sure the national Society will agree that it is exceedingly important that the technical information which the members of the Local Sections have should see the light of day.

MR. FRENCH (New York): At the Conference Luncheon this noon, Professor A. M. Greene threw out the suggestion that in years to come the best papers would probably come to the Society for the general meetings through the Sections. As a commentary on that, I would like to call attention to the fact that at the 1917 Annual Meeting we have assigned on the general program, as a result of a review of the Sections papers for the past year made by the Publication Committee, four Sections papers. Last year we had five or six. As a general rule there are about half a dozen Section papers, selected from those published in THE JOURNAL, which are given for discussion at the Annual or Spring Meetings of the Society.

I think that clearly indicates that the bulk of the papers presented before the Sections are either quite local in character, or else, as Professor Richards has just suggested, more popular in character than would be considered as suitable for permanent record in the annual volume of TRANSACTIONS. As a matter of course that would be expected. It is desired to have the Sections' meetings of general interest and treat subjects of local interest, and I doubt very much whether many Sections meetings can be devoted to the highly technical matters that the Society would wish to put on record in the annual volume of TRANSACTIONS.

Nevertheless, I would like to impress upon all of the Sections' representatives that the strength of the publications of the Society must eventually rest with the Sections, and it is very evident why that is so. It cannot be expected that a committee of five members, the majority of whom necessarily live in the East, acting as a Committee on Meetings, can select papers for the Annual and Spring Meetings which will be entirely representative of engineering progress in this country. Engineering is too varied in its characteristics and the country is too large to make it possible for any five men to secure thoroughly representative papers. With twenty-one Sections, such as we have, representative of different parts of the country from coast to coast, and from Canada to Louisiana, we ought to be able to put on record the most important engineering events that are occurring throughout the country. It ought to be possible for the members of any Local Section to so keep in touch with the engineering progress in their vicinity that two or three papers a year could be secured dealing with the important events in their vicinity. For example, from the Pacific slope we would naturally have, as we did this last year, a paper on oil refining, or, as in a previous year, a paper on gold dredging, or, as at another time, a paper by Professor Durand on the hydroelectric developments of the Pacific slope. In New York we would expect, as we have already had, a paper on elevators for tall buildings. From the Northwest we would expect papers on coal handling, and grain handling, such as we have already had, and from New Orleans on the drainage and irrigation work carried on there.

What is desired is to have the backing of some committee for every paper that is published in THE JOURNAL, so that it is known that the paper is of some merit in the judgment of a body of our representative engineers. For example, if in Chicago there should be some engineering developments, some research engineering processes, upon which a paper could be secured which might not be considered very suitable for a joint discussion or a local meeting, but would be worthy of publication in THE JOURNAL and for publication in the TRANSACTIONS afterward, might it not be possible for the Local Committee to secure that paper, present it at a meeting where some other more popular paper was given, presenting it by title, or by giving a very brief abstract of it, and stating that it would appear in THE JOURNAL and call for discussion?

We need about two papers a year from each Section, papers of sterling merit, to keep THE JOURNAL up to the standard required for a representative mechanical-engineering journal in this country, and the problem is to work out some basis on which the Local Sections can get these papers. I believe that through the Sections Committee and the Publication Committee a method could be worked out by which the important engineering developments will come to the Society for permanent record.

A little incident came to my attention yesterday. I was talking to one of our librarians. He mentioned that the searches called for and the other work and investigations done by the library employees were more frequently for members of this Society than for any other society. We know that our members send in a large number of calls to the library for information, and I believe that it is largely due to the fact that in THE JOURNAL we have reviews of important articles in other periodicals. Apparently the effort to make THE JOURNAL representative of engineering progress through those reviews is being appreciated by the membership.

Now, cannot we make it more appreciated by having the Sections get together the material that represents the engineering development going on in the country—the machine-tool industry in Cincinnati, the hydroelectric development work on the Pacific slope, and so on throughout the country, and have the material come in backed by the committee in the particular section where the material is secured, so that when the Publication Committee receives it they know it is good matter and worthy not only to be published in THE JOURNAL, but later to be presented at the Conventions and to appear in the annual volume of TRANSACTIONS.

MR. STARKWEATHER (Boston): The Sections stand for the Society to a large percentage of the members, men who never come to New York, and never see the activities in the Engineering Building, or attend an annual convention. We in Boston are very favorably and fortunately situated, in that we draw from a large membership, and we have a variety of interests. Our Section has appointed a Research Committee and a Papers Committee. We have had three general meetings this season—one on trench warfare, one on aeroplanes, and one on shipbuilding. One of the subjects, The Building of a Modern Plant for Submarine Destroyers, would make a good paper.

MR. WHITE (Milwaukee): We have planned a meeting which we think will result in a paper of general interest, and that is on the question of forgings. We have in Milwaukee the largest forging press west of Pittsburgh. That press at the present time is running night and day, mostly on Government work, varying from guns on down. It is proposed to hold our meeting at the works where the press is located and have addresses by about six of the technical experts who have to do with the forgings. We

propose, for instance, to ask a chemical man to tell us about the billets, about the basic and open-hearth processes. Then we propose to have the superintendent of the forging plant tell us his difficulties in forging—the time of heating, the kind of ingots he wants for certain forges, etc.—and then we propose to make a visit to the forging shop and see the forging press in operation.

After this first meeting we intend to have another meeting with discussions by technical engineers as to the possibility of adapting, for instance, low-carbon forgings, high-carbon forgings, nickel steel, chrome and vanadium, etc., to the different work.

MR. PRINDLE (New York): The New York Section has tried an expedient that promises very well. On our announcement postcards we have space for suggestions for papers and we also make a place on the reply postal card for suggestions. This has resulted in a wealth of suggestions which insures getting a paper that is bound to be popular.

MR. DELANY (San Francisco): There seem to be two difficulties at present in securing papers in San Francisco. One is that a great many of the best engineers are away from San Francisco on special work for the Government. Several declined for the reason that they were doing special work that is confidential at the present time. That is a difficulty which is probably met with in other Sections, and in San Francisco we would like to know if there is any way of overcoming it.

MR. SARGENT (New Haven): We recently had a meeting of the Connecticut Section under the auspices of the New Haven Branch at which Professor L. P. Breckenridge gave a paper on the Conservation of the Coal Supply. The paper will be read at the Convention under the title of The Fuel Problem. That is our first contribution. We expect to have two or three others, perhaps more, during the year, and will endeavor to have these of local interest, and technical interest, but in Connecticut—not more perhaps than other places—the mechanical engineer is a member of the manufacturing corporation, and he very soon reaches a point where he is not permitted, perhaps, to be too explicit in the matter he gives out, giving in too much detail something that concerns his particular manufacturing plant, and this is especially true at the present time as the country is at war.

For instance, we have in Waterbury perhaps the largest interests in the manufacture of brass in the country, and it would be rather difficult at the present time to have any of the engineers employed in these various brass mills deliver a paper. We are manufacturing munitions in New Haven and in Bridgeport in large quantities. We are manufacturing in New Haven and in Hartford the Lewis machine gun. It would also be very difficult to get men to give a paper on these subjects.

MR. LANGEN (Cincinnati): We have had no trouble in getting papers. We get them nearly all by personal contact, going to see the member and having a talk with him and telling him what is expected. We ask him to make the paper short, and ask him to stand for all of the questions that the members care to ask. If a member has a paper which will take forty-five minutes in its presentation, there will probably be an hour or an hour and a half of discussion. The members ask all sorts of questions and the discussion usually brings out more than the paper.

### THE SECTIONS AND RESEARCH

PROFESSOR RAUTENSTRAUCH: The question of research is very important, because it tends to raise the plane of activity of the Local Sections of the Society. Unless we have some definite objective of this sort, we are very liable to go to a lower level of operation than we would ordinarily go if spurred on by this sort of an incentive.

The difficulty lies very largely in making clear just what sort of thing is required under the head of research. The term generally strikes a little fear in the heart, as usually associated with something rather profound, like the integral sign Professor Richards referred to a while ago. A great deal of research does not consist of that sort of thing at all, but consists of rather systematic and logical arrangement of subject matter which need not necessarily be symbolically or formidably presented.

There are in a great many Sections problems that are peculiar to that Section, and it is an attempt to bring out the particular things that are of interest in that Section that the Committee on Research is being formed. The difficulty in doing this sort of thing is generally in the definition of the problem, and very often a considerable contribution to research is made by simply defining the problem. There is no difficulty in getting men to work on a particular line of investigation if the importance of that line is pointed out. That is what makes the difference between the big physicist and the little physicist. The big physicist can define what sorts of problems are real problems, and the little physicist is a man who fiddles around with something that is perhaps very complicated, but yet at the same time doesn't contribute very much to human progress.

As a suggestion, suppose we take the work in the Milwaukee Section. Mr. White is one of the most eminent engineers we have on the design of water wheels, and he knows that there are certain problems in water-wheel design that will bear investigation, and that we are in need of data or information along particular lines which will promote the use of water-wheel design. Why should there not be, then, a clear definition of the whole field of water-wheel design for the purpose of pointing out wherein there is a lack of certain information.

Again, in the Bridgeport district, where brass work is so prominent, there is the question of the manufacture of brass parts, the question of lubricants for the cutting of brass. In many of these works a very large number of lubricating compounds are used. Let a clear definition of what are the essential characteristics of a lubricating compound be given. Let the men who are interested in that particular thing make a statement of the state of the art, giving a clear definition of what are the things we need to know about in connection with that particular subject, and when that is once defined we will find certain fields on which we have no information. We have a great many young college men who are working in this industry, and we want to attach them to the Society at this critical time in their work and get them interested in the Society. We want to get them to contribute to the TRANSACTIONS and proceedings of the Society and become real live members. Let us point out to them that there is a problem worthy of their consideration, and by pointing that out and getting them organized so that they can go to work, we will get real information for the TRANSACTIONS of the Society, and save the number who would ordinarily become driftwood in the organization.

It is that sort of thing we want to accomplish through the Committee on Research.

PROFESSOR RICHARDS: At the University of Illinois we had the first engineering experiment station organized in this country, or in the world, perhaps. It has not been long since most mechanical engineers were inclined to shy away when the term "research" was used. We were inclined to look upon the term as one that had no particular concern with actual industrial processes, and was all right for the college fellows who wasted their time upon it. That attitude has changed radically within a very few years. This war, of course, will do more to bring to each of us the realization of the absolute necessity for research than would have been possible in any other way.

One of the principal difficulties in the research field is that research costs money. If in any section of the country, where there is a community of interests such as we find in many of the New England States, due to the growth of a particular industry, that industry realizes there are difficult problems which it needs to know more about, and if the men interested can get together and provide a fund and either employ a man and get him to work or perhaps make use of some of the existing research agencies, and by supporting these agencies in a financial way, getting those competent to study in a scientific way the abstract problems presented, that will be one way of doing it.

In the Engineering Experiment Station at Illinois we have been endeavoring, so far as practicable, to encourage coöperative investigations. By coöperative investigations I mean that we furnish such facilities as we may be possessed of, with the understanding that the coöperating agent will provide the funds for materials and supplies, and also provide the special apparatus which may be required to be designed and built for the particular investigations, and also supply the funds covering the cost of special investigators that may be needed to be employed on a full-time basis. We have at the present time a number of rather important investigations under way. One of the most important, perhaps, came about as a result of a piece of research work which we had already done in the coking of coal. It was found that the by-products of the processes devised were of rather unusual character. An American creosote company was given a sample of the by-products, which we had discovered was exceedingly rich in creosote, and in view of the fact that the war had cut off the supply of creosote, most of which came from Germany, they became very much interested in the process. The president of the

company has already supplied us with a fund of $10,000 for the work, and is ready to supply as much more, to carry out on a larger scale the investigations originally carried out on a more or less limited scale.

Since we are a state institution, supported by the people of the state, every coöperative arrangement of this sort is made with the understanding that the results of such investigations belong to the University of Illinois and are available to all of the people of the state.

In a great many of the states during recent years these engineering experiment stations, similar to the one that was organized at Urbana some fifteen or sixteen years ago, have been organized, but most of them are merely for the purpose of doing what we call commercial testing, as distinguished from real research, and yet it is quite possible that in the long run these agencies could be used to coöperate with the industries in that particular section, remembering in all cases that engineering research is tremendously expensive; that one can not guarantee results, and that the investigation may need to be continued for years before satisfactory and valuable results can be secured.

MR. GEIER (Cincinnati): There is no doubt considerable wasted effort now on the part of manufacturers in the same line of business trying to duplicate various laboratory tests and researches. Every concern is doing some research work and it is a waste of money for two concerns to be doing practically the same work, and duplicating the results of each other. I have been suggesting to some of the manufacturers in Cincinnati the possibility of their having an entirely private research laboratory, owned and controlled by a group of manufacturers, or possibly making it more public by attaching it to the university, and having the work done under the direction of the university authorities. No steps have been taken that are definite, but the matter is becoming more urgent as industry finds it necessary because of some of the changes in industrial conditions.

Many heads of manufacturing concerns, who are concerned primarily with the commercial side of the proposition, do not have a realization or appreciation of just how much good a research laboratory on proper lines would be to them from a financial standpoint. I believe if the Society would make an appeal, not only to its membership, but to the managements of industry throughout the country, and place before them in a very practical and persistent manner the need of the country, and the need of the individual manufacturers throughout the country, for a movement of this sort, it would be most helpful. People are listening much more carefully than they used to to suggestions of this sort. Now is the opportune time to make such suggestion, and an appeal should be made either by the committee or the incoming president to industrial managers generally to take a broad viewpoint of the matter, and see if they cannot organize in each community a real research laboratory.

MR. WALLACE (Indianapolis): If the war has taught any one a lesson it has certainly taught the wide-awake manager or manufacturer that research of the right sort on the right basis is of inestimable value. There is a great deal of research work that can be done along manufacturing lines that would not necessarily entail a great deal of expense. For instance, the question of labor is one of the greatest questions confronting the American manufacturer today, and with regard to the question of labor in this country, the subject has not been touched. We as a manufacturing organization went after that question and worked out a very comprehensive program for reducing the labor turnover in our company. We are getting results and during the last three months our labor-turnover percentage is going down in spite of the fact that the acute shortage of labor has tended to increase the difficulties of the labor situation, and especially the labor turnover.

Again, the manufacturers in a given locality, under the direction of the Local Section in that locality, could perhaps get together and work out problems of research investigation and analyze the causes for scrapping lots of material. In our factory we put that campaign on a patriotic basis. We said to our people at one of our factory meetings, that saving material is a national duty, and we want that as a slogan. If all the local sections in a given locality would get together and concentrate on that question, we would get results which would be of value to everyone.

MR. HAMILTON (Ontario): In Toronto, we are just getting started on the mechanical side of the research problem. The Manufacturers' Association and the government have been financing the matter, but up to now it has been more in connection with the chemical industries. I got notice the other day that the Research Committee of the Manufacturers' Association was ready to take up the research work in coöperation with the mechanical engineers, and especially with the users of iron and steel in the district. In the course of the next few weeks we will form some sort of a joint organization between the bodies that are interested in that problem, the local mechanical engineers and the Manufacturers' Association, and promulgate the problems of the mechanical engineers.

At the close of the meeting Professor Richards gave a timely example of how the Sections could render practical service—he urged the Sections to enter into the national movement for the conservation of fuel. The knowledge at their command would enable them to give practical and special information in their communities regarding the proper use of fuel in heating the homes and the importance of putting the boiler plants in good condition and operating them more effectively, and to bring home to everyone that conservation is a problem everyone has to face squarely.

## SECTION MEETINGS

### BALTIMORE

*December 19.* At the second meeting of the Section, Wm. W. Varney, Chairman, reported on the Annual Meeting of the Society and appealed to the members of the Section for papers bearing on the local industrial interests of Baltimore.

The Secretary, A. G. Christie, discussed the fuel situation, and outlined the efforts that are being made to educate the firemen and increase boiler efficiency. He called attention to a Baltimore conference of operating engineers and a proposed assembly of firemen, urging the hearty support of members of the Section.

Dr. D. J. MacAdams, Jr., of the Engineering Experiment Station, U. S. Naval Academy, Annapolis, presented a paper on Microstructure and the Physical Properties of Metals, in which he described the methods followed in preparing a section for metallographic inspection under the microscope. Solutions of metals were discussed and illustrated by slides. Eutectics were treated and sections of tin-lead and copper-zinc compounds shown and the effect of heat treatment was illustrated by slides. Some interesting information was developed with regard to the steels of indicator springs, tool steels and the processes of tempering.

The second paper of the evening, entitled Some Mechanical Problems of the Fertilizer Industry, was presented by Samuel P. Whiteside, Mem.Am.Soc.M.E. He said that the mechanical engineer finds that in special chemical apparatus many mechanical refinements have been overlooked. Widely used machines when applied to fertilizer factories usually develop weaknesses. For example, grab-bucket service transforms a bridge crane from a tool of occasional convenience into a steady worker, but in this new service the machine needs some training and development before it will pass the endurance test.

*January 10.* A meeting under the joint auspices of the Engineers' Club, the various stationary engineers' associations and the Baltimore Section, was held for the purpose of interesting the firemen of the city in the subject of fuel saving.

Mr. Charles H. Bromley, Associate Editor of *Power*, gave an address on How to Get the Most Out of Coal. A fuller account of the meeting will be published in a later issue of The Journal.

A. G. CHRISTIE,
*Section Secretary.*

### BIRMINGHAM

*December 20.* The subject of conservation of fuel was discussed by F. G. Cutler, Mem.Am.Soc.M.E., and J. W. Moore, Assoc-Mem.Am.Soc.M.E., and it was believed well to formulate plans at some future date with the idea of establishing some fixed methods of procedure in the matter of coal conservation.

A letter was read from the American Uniform Boiler Law Society urging the Local Section to take steps toward securing a boiler law for the state of Alabama, and the following were appointed to investigate the advisability of having a law passed in Alabama adapting a uniform boiler code: F. G. Cutler, Chairman, H. C. Ryding and C. B. Davis.

A short talk on the Handling of the Sick and Wounded in

Actual Warfare was given by H. B. Hess, United States Medical Corps.

A talk on The Use of Graphite as a Boiler Scale Preventative was given by Samuel Stewart, Mem.Am.Soc.M.E., who related experiences at the Thomas Plant of the Republic Iron and Steel Company. Mr. Stewart brought out that after using graphite as a boiler solution, he found quite a saving of coal was accomplished, even though an increased load was put on the plant; it was absolutely necessary that the graphite be kept in suspension and the way this was accomplished was to insert an air pipe in the bottom of the tank containing the water with graphite in the solution. The graphite was kept in suspension by pumping air into this pipe, the air coming either from blowing engines or compressors. Amorphous graphite was much more satisfactory than flake graphite, and cost between 7 and 8 cents a pound; using about 0.005 lb. per horsepower per day, the entire cost of cleaning 9,000 hp. in boilers was about $14.00 per day. The best place to treat boiler feedwater was outside to keep scale from forming, but practically all boiler feedwater constituted a separate problem in itself and what was found to be good in one case would not do in another. The secret of the success of graphite was to keep it in suspension, the idea being that the small particles of graphite would combine with the small particles of scale and make them easy to remove. Graphite could not be expected to be of any benefit if the water contained acids.

At the conclusion of the meeting C. B. Davis, K. Lanrebe, Paul Wright and O. C. Thurlow were appointed a Committee to prepare a program on the conservation of fuel, in coöperation with the Alabama Technical Society.

W. L. ROUECHE,
*Section Secretary.*

## BOSTON

*January 22.* An informal reception was tendered to the President of the Society, Mr. Charles T. Main, at the Engineers' club. Among the several addresses given was one by Mr. Balch of the Boston *Transcript* on Europe after the War. A full account of this meeting will be given later.

W. G. STARKWEATHER,
*Section Secretary.*

## BUFFALO

*December 12.* At the General Meeting of the Engineering Society of Buffalo, W. Fostergen, Manager of the Independent Bureau of Philadelphia, gave an address on Industrial Housing in which he described the work being done by large corporations in this country in furnishing proper housing for employees. Special stress was laid on the point that it is more advisable to make homes sanitary and agreeable than it is to go into great detail regarding conveniences.

*December 19.* Mr. H. O. Hem. Mem.Am.Soc.M.E., gave a paper before the society on The Evolution of the Scale, in which he brought out the advancement in technical development of the modern scale as compared with the crude methods of early scale manufacturers.

*January 9.* At the fourth general society meeting L. C. Lowenstein, Mem.Am.Soc.M.E., gave a paper on The Widening Field of the Steam Turbine as a Prime Mover, in which he called attention to the advancement made in steam-turbine work and its widening application, not only as a prime mover for generators, but also for marine propulsion and centrifugal compressors such as blast-furnace blowers.

Other meetings of the societies affiliated with the Engineering Society of Buffalo held during the month included the following:

*January 16.* The American Electrochemical Society Section held a meeting at which a paper on Electric Steel Castings was presented by Mr. R. F. Flintermann of the Michigan Steel Castings Company, of Detroit.

*January 23.* At a special meeting of the National Founders' Association moving pictures illustrating modern foundry practice were exhibited. They emphasized the rapid strides made by the more modern foundries throughout the country in the use of molding machines and other labor-saving devices.

*January 30.* A meeting of the American Chemical Society was held.

F. B. HUBBARD,
*Section Secretary.*

## CONNECTICUT SECTION

### *Meriden Branch*

*December 21.* Chairman C. K. Decherd presented a detailed report of the Annual Meeting of the Society, in which he stated that the work of the Engineer in the War was the keynote of the entire meeting. Introducing the subject of the evening, research work, he said that research may be an endeavor to find something new for the benefit of the world, or information now lacking which is needed, or it may be an effort to make things we now have more efficient and resultant in greater good for all.

Ten-minute papers were then read by J. L. Hutchinson and Charles N. Flagg, pointing out the need for accurate data in engineering organizations and declaring that much of the data now available is either obsolete or inaccurate. In Mr. Hutchinson's paper he stated that the subjects selected for his talk were common ones and universally used. It very often is the case that data available have been worked out to prove some specific problem but when an endeavor is made to use these data on a different problem variables are found which make them practically valueless until they have been supplemented with more details.

Mr. Flagg stated that the work of the heating engineer has never been, and probably never will be, reduced to an exact science. The general practice has been to acquire as much data as possible from whatever source it may be obtained, absorb as much theory as possible, and then when a problem presents itself the task has been to fit the theory to the job, modifying it by the actual experience of the designer.

CHARLES N. FLAGG,
*Section Secretary.*

## DETROIT

*January 25.* At a joint meeting of the Section with the Detroit Engineering Society a three-part paper on the Complete Description and Test of a Modern Lake Steamer was presented. The topics included: Part I, Description of the Hull, by H. W. Miller; Part II, Description of the Machinery, by Geo. B. Turnbull, Assoc-Mem.Am.Soc.M.E., and Part III, Tests, by A. G. Mattison, Mem.Am.Soc.M.E.

S. J. HOEXTER,
*Section Secretary.*

## ERIE

*December 14.* At a meeting held jointly with the Engineers' Society of Northwestern Pennsylvania and the Erie Board of Commerce, a large and enthusiastic audience representing the various organizations listened with interest to an address made by Prof. Dexter S. Kimball, Mem.Am.Soc.M.E., on Industrial Management.

M. W. SHERWOOD,
*Section Vice-Chairman.*

## INDIANAPOLIS

*January 25.* In accordance with a precedent started last year the Section held a joint meeting with the Indiana Engineering Society and the local section of the A. I. E. E. on the occasion of the annual meeting of the former society. Each organization furnished a well-known speaker, Mr. A. S. Hurrell representing the A.S.M.E. Section. A detailed report of the meeting will be published in a later issue.

L. W. WALLACE,
*For the Secretary.*

## MINNESOTA

*December 7.* At the joint meeting of the Section with the A. I. E. E., and several other technical societies, L. D. Wildman of the Central Department, U. S. Signal Corps, delivered a lecture on the subject of War Time Work of the U. S. Signal Corps in Aviation and Electrical Communication. A most interesting account of the various branches of the service was given, including considerable detail with regard to the equipment, training and practice pertaining to each branch.

E. A. WILHELM,
*Section Secretary.*

### NEW YORK

*January 8.* The chairman of the meeting called attention to the loss of three members of the Executive Committee of the New York Section due to their participation in war activities. After discussion the following motion was unanimously adopted:

> RESOLVED: That the two remaining members of the New York Section Committee be instructed to appoint three members to fill the vacancies in that committee for the unexpired terms of the resigned members, such appointments to be subject to the approval of the general Sections Committee and the Council of the Society.

The Committee on Local Sections were the guests of the evening, with the following members of the committee present: D. Robert Yarnall, chairman; L. C. Marburg, Walter Rautenstrauch, H. B. Sargent. Mr. Yarnall outlined the ambitions of the committee with regard to the development of the Section activities, after which Professor Rautenstrauch presented an excellent paper on The Relation of Manufacturing to Banking and Research. Professor Rautenstrauch described the development of these relations as advanced by the Industrial Service Department of the National City Bank of New York, and the members present were much impressed by the potential growth of this relation between the engineers and banks of the country. Mr. E. A. Baker of the National City Bank was present and discussed the paper, as did Messrs. H. B. Sargent, George K. Parsons, W. H. Greul, and others.

Previous to the meeting a buffet supper was served which was thoroughly enjoyed by those who attended. The opinion was generally expressed that if the majority of members in the New York Section were cognizant of the opportunities these pre-meeting dinners afforded for acquaintanceship they would be very generally attended. Members not particularly interested in the paper of the evening would find it profitable to be present at the dinner. In future those who attend the meetings will be asked to register and records will be kept so that at the end of the year those who have participated in the meetings will be known.

The Executive Committee of the Section wishes to extend a cordial invitation to all members to attend its meetings whenever in the city. The committee is especially desirous of having out-of-town members participate in the "get-acquainted" supper held in the Engineering Societies Building at six o'clock on the meeting night. Meetings in New York are usually held on the second Tuesday. An exception to this rule will be made in February, owing to Lincoln's Birthday.

W. HERMAN GREUL,
*Section Secretary.*

### PHILADELPHIA

*January 22.* Prof. William L. Cathcart, Mem.Am.Soc.M.E., and retired from the U. S. Navy, gave an illustrated lecture on The War on Land and Sea. Through the courtesy of the British Pictorial Service, Professor Cathcart showed thirty official views of the recent fighting in Flanders and other places on the front.

On the invitation of the Section, members of the Illuminating Engineering Society attended the meeting.

JOHN P. MUDD,
*Section Secretary.*

### PROVIDENCE

*January 15.* The Development of the Submarine was the title of the paper presented by Albert Cook Church, one of the best-informed men on this subject in the country. Mr. Church is a consulting engineer and has done work for all the allied governments during the present war and his knowledge both of their types and of German types is very extensive. The lecture was illustrated by a number of slides showing the capture, salving and repair of the German mine-laying submarine UC-5; the developments of the submarine from the earlier types to the present-day super-submarines of enormous tonnage, including plans, interiors with all the maze of intricate machinery, and torpedoes, showing their actual use in warfare; and the attack and sinking of steamers, battleships and submarines. The mechanical principles involved in the design and operation were carefully explained in detail.

In addition to this general meeting several Section meetings were held during January, which included:

*January 8.* The Machine Shop Section meeting, at which a paper on Gages and Their Use in Quantity Production of Rifles and Munitions was given by T. Frederick McClosky.

*January 9.* Under the auspices of the Power Section, Mr. Frederick B. Kenney, of the Blackstone Valley Gas & Electric Company, gave a paper on Central Station vs. Isolated Plant.

*January 11.* The Efficiency Section held a meeting at which a paper on Some Aspects of Scientific Management was given by Albert E. Thornley, of the Narragansett Machine Company.

JAMES A. HALL,
*Correspondent.*

### ST. LOUIS

*November 23.* A report of the new Research Committee of the Section was read by Mr. Liebee, emphasizing the fact that efforts were being made to interest the manufacturers of St. Louis in the work of this committee. The speaker of the evening was Prof. C. S. Boucher, of Washington University, whose timely address on American, English and French Relations, Past and Present, was of great interest to those present. The meeting was held at the new Statler Hotel, and permission was granted by the management to those present to make an inspection of the mechanical equipment of the hotel.

*December 19.* At the joint meeting of the Section with the Associated Engineering Societies of St. Louis, George B. Evans, Mem.Am.Soc.M.E., presented an interesting paper on Power-Plant Installation by By-Product Coke-Oven Plants, in which he referred particularly to the power plant recently constructed in connection with the by-product coke-oven installation of the Laclede Gas Light Company at Carondelet, St. Louis. While this plant is of comparatively small size it has been laid out and constructed with all of the care and regard for best engineering practice in connection with the construction of a modern central station plant.

Opportunity was taken at this time of bringing before the Associated Engineering Societies and the Engineers' Club the matter of establishing a research laboratory in the district of St. Louis. Mr. H. R. Setz, Chairman of the Research Committee, solicited the support of all the engineering societies in the St. Louis district.

*January 16.* A joint meeting of the Section with the Associated Engineering Societies of St. Louis was held at the Engineers' Club under the auspices of the A.S.M.E. Section. Mr. Paul Diserens, Mem.Am.Soc.M.E., presented a paper on The Recovery of Gasoline from Casing-Head and Natural Gas.

R. L. RADCLIFFE,
*Section Chairman.*

## Student Branch Meetings

### POLYTECHNIC INSTITUTE OF BROOKLYN

*December 1.* Mr. Wunch and Mr. Fialkoff were elected at this meeting of the Branch, to serve on *The Engineer* board as representatives of the Mechanical Engineering Society. Means were discussed for increasing the attendance at the meetings, as the war has caused the loss of many members active in the affairs of the Branch, including Prof. Wm. D. Ennis. After the regular business a paper was presented by Mr. McAustin on Lubrication. Mr. McAustin told of the many problems which had to be solved in this field, especially that of the aeroplane motor. The speaker said that the lack of the proper lubrication hinders the progress of the advancement of this type of motor.

The Polytechnic Institute of Brooklyn has been very active in its coöperation with the Government in the war. Patriotic committees have been organized on smokes, correspondence, comforts, speakers, etc., whose various duties are to supply the Polytechnic men in service with comforts and keep them in touch with the Polytechnic affairs. A company of students has been organized by Professor Chittenden, and has been mustered in the 23rd Regiment; it drills at the armory every Friday.

Besides the patriotic topics given by prominent speakers at the chapel service, courses are being given at the Institute relating to military work, and which include military surveying and naval architecture. By hard and conscientious study, Polytechnic Institute is doing its bit in preparing for the huge rebuilding after the war.

NATHAN N. WOLPERT,
*Branch Secretary.*

## PURDUE UNIVERSITY

*November 20.* Good Carburation was the paper presented at this meeting of the Branch, by Prof. O. C. Berry, of the Gas Engineering Department. Professor Berry discussed very clearly the vital principles that are necessary for good carburation, and backed each statement by actual results taken from tests, which had been tried out in the university laboratory. Many different kinds and types of carburetors, taken from an engineering standpoint, were explained and their good and bad features discussed. The different adjustments of the different carburetors were also explained and discussed and the inability of each to meet the ideal requirements. Professor Berry outlined the requirements for an ideal carburetor and the conditions they should be designed to meet under average service.

A talk was given at the December 4 meeting on the Manufacture of Munitions and Aeroplane Parts by O. W. Kastens, a senior in the School of Mechanical Engineering, on his past summer experiences. The different methods in the manufacture of munitions, and especially the methods used in making the detonators, were described very clearly, so far as the speaker was at liberty to do so. Because of the nature of the subject only very general ideas and methods could be openly discussed. The standardization and interchangeability of aeroplane parts was discussed very clearly, and a very good idea was given on what is being done towards helping the Allies with the construction of aeroplanes.

Purdue University has been very active in its coöperation with the Government in the present crisis. Approximately out of the two thousand students in the university last year, only sixteen hundred have returned this year, and many are leaving daily for service in different sections of the army and navy. Many have attended the different training camps and received commissions, while others are enlisting in the signal corps, the artillery and especially in the aviation section. About thirty professors have gone either directly into the army, into the training camps or have enlisted in the ordnance department. Purdue has shown her mettle also by raising $10,000, which was her assessed share of the Y. M. C. A. Fund, and $2000 for an ambulance equipment for the Purdue Ambulance Corps; and, in addition, she has passed the required mark of the Y. M. C. A. Fund by nearly $7000. A movement is now under way in which the juniors, and especially the seniors in engineering, may enlist in some form of service and be allowed to complete their studies, and then go directly into army service.

CLAUDE KEGERREIS,
*Branch Secretary.*

## RENSSELAER POLYTECHNIC INSTITUTE

*November 7.* T. H. Thorn gave a lecture on experimental turbines at the fourth meeting of the Branch for the season. Mr. Thorn confined his talk chiefly to an experimental turbine built by the Westinghouse Company. He detailed the construction and arrangement of the turbine, gave the speed and power developed, and described particularly one that failed under test, delineating the causes of the failure as shown by the machine afterwards. The speaker explained the conditions leading up to the break and gave a few interesting facts concerning the result of the explosion.

S. F. Jeter, Mem.Am.Soc.M.E., followed with an instructive talk upon the strength of riveted joints. Mr. Jeter's talk took the form of an analysis of the boiler seam, characteristics generally overlooked, plate thickness, spacing and pitching rivets, and quick, easy methods of determining the important features of a joint from given data. The speaker illustrated the joint by slides, showing charts adaptable for finding all the necessary data concerning a joint when certain dimensions have been given.

The Institute has been very active in its coöperation with the Government at the present great crisis. There is a long list of Rensselaer men in service, many holding commissions in engineering regiments now in France. Out of the classes of 1918, 1919, 1920 and 1921, 102 men have left school to enter the service. Of the non-graduates 83 have entered the service, and 216 of the graduates are on the Roll of Honor. Aside from this total there are 16 men engaged in the civilian part of the war work. This means a grand total of 417 men on the Roll of Honor. There is an optional course of military drilling offered by the school, and the present two companies formed have a record of one hundred and sixty men.

A "smoke" fund has also been created, and this is serving a double purpose. Each man is expected to contribute ten cents or more if he wishes. Six $100 Liberty Bonds of the last issue have been set aside, and as often as the fund permits, one of them is paid for and turned over to the Troy *Record* to be used in their large Smoke Fund. The Library fund which has recently been adopted has been very successful in its purpose of supplying reading matter for the soldiers in camp. As Dr. Wier, of the American Library Association's Committee, said: "The books thus made accessible to the soldiers and sailors have a double purpose—first, they provide wholesome entertainment to the men; and second, they constantly keep before them the high ideals for which they are fighting."

*December 20.* At the fifth regular meeting of the Branch R. P. Kolb reported his visit to the Conference of Student Branches held at the Annual Meeting.

A paper on the Spiers Falls Power House, covering the layout and size of the plant, and diagram of the wiring, was given by C. A. Jacobson.

Due to the fact that Mr. Morretti was called into government service, G. H. Carragan was elected his successor as Vice-Chairman of the Branch.

R. A. MARRIOTT,
*Branch Secretary.*

## STEVENS INSTITUTE OF TECHNOLOGY

The president of the Stevens Engineering Society having been called into government service, new officers were elected at the opening of college, as follows: Raymond Mileham, president, and Paul Hiller, vice-president.

A petition was submitted by the Seniors to the Trustees of the College asking permission to eliminate holiday periods and do extra period work in order to finish the college course. The petition was granted and the Senior Class will receive regular college degrees, but will graduate earlier.

*December 13.* The second meeting was called for the purpose of electing a successor to G. Crosby Hiss, treasurer, who had enlisted in the U. S. Naval Reserve. Mr. Lincoln B. Aquadro was elected to carry on his work.

*January 14.* Mr. Paul Hiller gave a talk on the new steam automobile shown at the recent Automobile Show, and R. Mileham spoke on Automobile Differentials.

The Inspection Trip Committee reported difficulty in arranging for the regular Wednesday afternoon inspection trips to plants of interest in New Jersey due to the order of the Fuel Administrator closing the plants on that day. A trip to New York later in the year was suggested.

A committee of three was appointed to prepare a new Constitution.

LINCOLN V. AQUADRO,
*Branch Secretary.*

## THROOP COLLEGE OF TECHNOLOGY

The following officers were elected to carry on the Branch work: Ralph T. Taylor, chairman, Clarence N. Ward, vice-chairman, and Retla Alter, secretary-treasurer.

The College has lost many of its faculty members and professors due to the war, and now has seven representatives on the Council of National Defense, three of whom are faculty members and four are trustees.

In the Mechanical Engineering Department most of the upperclassmen have enlisted and the majority are now lieutenants. To stop this depletion in numbers of the upper classes and to help the Government in every way possible, it was decided to graduate the Senior class on April 6 and the Junior class on September 15. The course for the Juniors will therefore be shortened, but they will be required to work through the entire summer. A course in shipbuilding similar to the one given at Lehigh University will be a required subject for the Juniors and Seniors. In this way it is hoped that a number of students after graduating will enter the shipyards to help in the construction of ships. Others will receive commissions in various branches of the service.

Throop has had compulsory military training since September 1916 under the direct supervision of a captain in the Army (always a West Point graduate) detailed by the Government and the students are consequently now fully qualified for active service.

RETLA ALTER,
*Branch Secretary.*

# EIGHTH ROLL OF HONOR

*ONE HUNDRED AND TWENTY-ONE additional names of members of The American Society of Mechanical Engineers who are now in the Service. This eighth list brings the total number of stars on the service flag to over 700.*

ALLEN, THOMAS H., Captain, 306th Engineers, Camp Jackson, Columbia, S. C.
ANDERSON, ARRID R., Corporal, Battery F, 324th Regiment, Field Artillery, Camp Sherman, Ohio.
ASHMUN, LOUIS H., First Lieutenant Engineers, War Department, Trench Warfare Branch, United States Reserve.

BACON, JOHN LORD, Captain, Engineer Officers' Reserve Corps.
BARNUM, CHARLES L., Lieutenant, United States Naval Reserve Force.
BARTON, CHARLES R., Second Lieutenant, Officers' Reserve Corps.
BATTEN, LORING W., JR., Ensign, United States Naval Reserve Force, U. S. S. *Wyoming*.
BAYER, GEORGE H., First Lieutenant, Ordnance Reserve Corps.
BERLINER, RICHARD W., Captain, 306th Engineers, United States Reserve.
BIXBY, WINFRED H., First Regiment Illinois Engineers, National Guard.
BLISS, EDWIN C., Lieutenant, United States Naval Reserve Force.
BOLGIANO, J. R., Second Lieutenant, Officers' Reserve Corps, Production Section, Carriage Division, Ordnance Department.
BRADY, LABAN J., Second Lieutenant, Company C, 5th U. S. Regular Engineers, Camp Skurry, Corpus Christi, Tex.
BROWN, JOHN WILSON, JR., Major Engineers, United States Reserve, Camp Lee, Petersburg, Va.
BUCKINGHAM, EARLE, Captain, Ordnance Department, Inspection Section, Gun Division, United States Reserve.
BURLING, HERBERT S., Second Lieutenant, Field Artillery, Officers' Reserve Corps.
BURROUGHS, J. H., Captain, Coast Artillery Reserve Corps, Acting Quartermaster, Coast Defenses of the Delaware.

CARSON, C. B., First Lieutenant, Officers' Reserve Corps, Carriage Division, Production Section.
CHEW, JOHN J., Ensign, United States Naval Reserve Force, Bureau of Ordnance, Navy Department, Washington, D. C.
COLE, CYRUS L., Captain, Ordnance Section, Officers' Reserve Corps.
COLVIN, JAMES A., Company E, 313th Engineers, Camp Dodge, Iowa.
COOPER, HOWARD, Signal Corps, Equipment Division, Specification Section.
CRANE, E. C., Second Lieutenant, Engineer Officers' Reserve Corps.

DICKEY, RALPH L., Lieutenant, Ordnance Department, Washington, D. C.
DIEMER, HUGO, Major, Ordnance, United States Reserve.
DODGE, ALBERT, Captain, 316th Infantry, Commanding Company J, United States Army.
DODGE, PARKER V. P., First Lieutenant, Ordnance Department, Washington, D. C.

EBEN, LEON A., Lieutenant, United States Army.
EDWARDS, H. H., Chief Machinist's Mate, Third Naval District, United States Naval Reserve Force.

FARNHAM, G. W., Second Lieutenant, Officers' Reserve Corps, United States Army, Fort Totten, L. I.
FOSTER, CHARLES C., 302nd Engineers, Company C, Camp Upton, L. I.

GFROERER, HERBERT, Second Lieutenant, Ordnance Department, Machine Gun Section, Carriage Division.
GILLAM, W. H., JR., First Lieutenant, Ordnance Department, Supply Division, United States Reserve.
GOING, CHARLES BUXTON, Major, Ordnance Officers' Reserve Corps, United States Army.
GUTHRIE, JAMES, Major, Ordnance Department, United States Reserve.

HAHN, CONRAD V., First Lieutenant, Division of American Ordnance Base Depot, France.
HALL, KEPPELE, Captain, Ordnance Department.
HALL, WINTHROP G., United States Army, Camp Devens, Mass.
HANDS, RONALD C., First Lieutenant, Ordnance Reserve Corps.
HART, HOWARD P., Ensign, United States Navy.
HAYS, JOHN C., Major Quartermaster's Department, United States Reserve.
HEILEMAN, FRANK A., First Lieutenant, Machine Gun Company, 54th Infantry.
HENDRICK, WALLACE M., First Lieutenant, 301st Engineers, United States Reserve.
HIBBARD, L. J., Lieutenant, 11th Regiment Engineers, France.
HODOUS, LOUIS W., Private, First Class, Section 542, United States Ambulance Service.

INGHAM, HOWARD M., Lieutenant (Junior Grade), United States Naval Reserve Force, Class 4.

JACKSON, J. H., Second Lieutenant, Ordnance Reserve Corps.
JACKSON, JOHN R., Captain, Ordnance Department, American Ordnance Depot in France, United States Reserve.
JACKSON, LUCIAN C., American Expeditionary Forces, France.
JACOBS, HENRY L., Camp Lee, Petersburg, Va.

KALEY, GEORGE B., First Lieutenant, Ordnance Reserve Corps.
KENT, ROBERT W., First Lieutenant, Officers' Reserve Corps, United States Army.
KINGSLEY, F., First Lieutenant, Officers' Reserve Corps.
KUGEL, H. K., First Lieutenant, Engineers' Reserve Corps, Company E, 310th Engineers, Camp Custer, Mich.

LANCASTER, W. C., Engineer Officers' Reserve Corps.
LAWRENCE, S. E., Captain, Engineer Officers' Reserve Corps.
LEWIS, F. H., Major, Ordnance Department, United States Army.
LIBBY, WILLIAM L., Lieutenant, Production Section, Gun Division, Ordnance Department, Washington, D. C.
LYNN, E. H., Captain, Coast Artillery Corps, United States Army.
LYNN, THOMAS H., Captain, Company H, Pennsylvania Reserve Militia Infantry.

MCCLELLAND, C. C., Company E, 306th Engineers, Camp Jackson, Columbia, S. C.
MCELROY, J. W., Captain, Ordnance Reserve Corps.
MCGRATH, F. P., First Pennsylvania Ambulance Company, 28th Division, Camp Hancock, Ga.
MCINTOSH, R. L., Captain, Ordnance Department, Officers' Reserve Corps.
MACLEAN, M. R., First Lieutenant, 9th Co. Infantry, Officers' Reserve Corps, Fort Niagara, N. Y.
MACLEOD, NORMAN M., First Lieutenant, Company S, United States Reserve, Camp Lee, Petersburg, Va.
MAIN, C. CURTISS, Signal Corps, United States Army.
MARSH, FRANCIS GRANT, Lieutenant, United States Navy.
MASON, EARL P., Lieutenant, United States Naval Reserve Force, Newport, R. I.
MATHER, HAROLD T., First Lieutenant, Coast Artillery Corps, Officers' Reserve Corps, Ft. Monroe, Va.
MAYNZ, T., Aviation Section, Signal Officers' Reserve Corps.
MEIXNER, B. A., First Lieutenant, Ordnance Reserve Corps.
METZ, W. R., Captain, Quartermaster Corps, United States Reserve, Fort Sam Houston, Tex.
MIDDLETON, HARVEY, Camp Funston, Kan.
MILLER, ERNEST P., JR., First Lieutenant, Ordnance Department, Officers' Reserve Corps.
MOON, H. A., Major, Rainbow Division, United States Army.

NIEMEYER, J. C. W., Captain, Quartermaster Reserve Corps, United States Army.
NORRIS, A. M., Ensign, U. S. S. *Missouri*.

PEASE, MAXFIELD, Machinist's Mate, First Class, United States Naval Reserve Force.
PHELPS, CLEON E., Second Lieutenant, Ordnance Department, United States Reserve.
PIRIE, H. L., Captain, Ordnance Department, British Expeditionary Forces, France.
POPE, HAROLD F., Captain, Quartermaster Officers' Reserve Corps.
POUND, JOSEPH H., Ordnance Department, 90th Division.

QUICK, RAY L., United States Naval Reserve Force.

RAYMOND, THOMAS E., First Lieutenant, Ordnance Department, Washington, D. C.
RIGGS, GEORGE, Sergeant, Company K, 107th Infantry.
ROGERS, JOHN I., Lieutenant (Senior Grade), United States Naval Reserve Force.
ROSS, HENRY B., First Lieutenant, Company F, 104th United States Engineers, United States Reserve.
RUBIN, HARRY E., First Lieutenant, Ordnance Reserve Corps, Machine Gun Section, Ordnance Department, Wilbur Wright Field, Fairfield, Ohio.
RUSSELL, FOSTER, First Class Private, Aviation Section, Signal Officers' Reserve Corps.
RYERSON, WILLIAM H., Captain, Class B, Engineer Officers' Reserve Corps.

SCHULTZ, WILLIAM W., Second Lieutenant, New Jersey Engineers.
SCRUGHAM, J. G., Major, Ordnance Reserve Corps, Production Section, Carriage Division, Ordnance Department.
SEARLE, DANA A., Ordnance Sergeant, Ordnance Corps, United States Army.

SHELDON, JAMES RHODES, JR., First Lieutenant, 28th Company, Coast Artillery Reserve Corps, Ft. H. G. Wright, N. Y.
SHRADY, C. D., Troop A, Squadron A, New York Guard.
SIBLEY, MARK MILLER, Lieutenant (Junior Grade), United States Naval Reserve Force.
SMITH, CHARLES W., Second Lieutenant, Signal Officers' Reserve Corps, American Expeditionary Forces, France.
SMITH, FREDERICK C., Second Lieutenant, U. S. Reserve.
SMITH, THOMAS W., First Lieutenant, Engineer Officers' Reserve Corps, General Engineer Depot, Washington, D. C.
SNYDER, WILLIAM R., First Lieutenant, Ordnance Reserve Corps, United States Army.
STONE, M. A., JR., Captain, Ordnance Officers' Reserve Corps.
STOVEL, R., Major, American Expeditionary Forces, France.
STRAHLMANN, OTTO E., First Lieutenant, Aviation Section, Signal Corps.
STRING, JOSEPH S., Captain, Ordnance Department, Gun Division, Production Section.
TAYLOR, CYRUS J., Chief Machinist's Mate, United States Naval Reserve Force.
THOMAS, CHARLES W., Lieutenant (Senior Grade), United States Naval Reserve Force.
THOMAS, JOHN M., Lieutenant, Officers' Reserve Corps, Ft. Sill, Okla.
THOMPSON, SANFORD E., Major, Officers' Reserve Corps, Office of Chief of Ordnance.
TOUR, REUBEN S., First Lieutenant, Ordnance Officers' Reserve Corps, Nitrate Division, Ordnance Department, Washington, D. C.
TUPPER, FREDERICK G., Lieutenant (Junior Grade), United States Naval Reserve Force.

VAN SYCKEL, F. T., Signal Corps, United States Reserve.
VOY, EDWARD L., Depot Battalion, 7th Regiment.

WERST, C. W., Lieutenant-Colonel, Russian Railway Service Corps.
WIELAND, CHARLES F., Captain, Officers' Reserve Corps, United States Army, Manila Ordnance Depot, Manila, P. I.
WING, CHESTER E., Ensign, United States Naval Reserve Force.
WOODS, G. H., Captain, Quartermaster Corps, United States Army.
WOODWARD, H. W., Second Lieutenant, 106th Engineers, United States Reserve.
WRIGHT, D. B., Second Lieutenant, 1st Division Staff, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.
WRIGHT, PAUL D., First Lieutenant, Ordnance Department, Officers' Reserve Corps.

# PERSONALS

***IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by February 17 in order to appear in the March issue.***

## CHANGES OF POSITION

A. R. CARLYLE, who for the past ten years has been designing marine engineer for the Union Oil Company, of California, has terminated his relations with the company and has recently been made surveyor for the American Bureau of Shipping, American Lloyds, District of Southern Cal., Los Angeles, Cal.

CARL T. HEWITT, formerly connected with the Remington Arms Union Metallic Cartridge Company, Inc., Bridgeport, Conn., has accepted the position of metallurgist and testing engineer with the Fafnir Bearing Company, of New Britain, Conn.

GEORGE S. BLANKENHORN, formerly connected with the Allis-Chalmers Manufacturing Company, of Milwaukee, Wis., as engineer in the department of the chief consulting engineer, has accepted a position with the American International Shipbuilding Corporation, of Philadelphia, Pa., in the department of machinery fabrication.

E. P. WORDEN has resigned his position of chief engineer for Henry R. Worthington to accept the position of mechanical engineer for the Submarine Boat Corporation, New York.

ALFRED L. AICHER, chief draftsman with the F. J. Stokes Machine Company, Philadelphia, Pa., has accepted a position with the Southwark Foundry and Machine Company of the same city.

JAMES BRAKES, JR., formerly in the employ of the Kimberly-Clark Company, Neenah, Wis., as testing engineer, has accepted the position of inspector in the power department of the Western Electric Company, Hawthorne plant, Ill.

WALTER H. RASTALL has become assistant sales manager for The Bauer Brothers Company, Springfield, Ohio. He was formerly affiliated with the Worthington Pump and Machinery Corporation, Cincinnati, Ohio, as engineer.

EDWIN A. MOORE has terminated his relations with the Union Switch and Signal Company, Swissvale, Pa., as works manager, and has assumed the duties of manager of the Liberty Ordnance Company, Bridgeport, Conn.

HENRY LINDENKOHL, until recently engineer of construction, American Locomotive Company, Schenectady, N. Y., has been appointed engineer of construction of the Worthington Pump and Machinery Corporation, with headquarters in New York. He will have charge of the design and construction of new shops and of additions to present shops.

FREDERICK J. HARDMAN, assistant examiner, U. S. Patent Office, Washington, D. C., has become associated with the patent department of the Dayton Engineering Laboratories Company, Dayton, Ohio.

B. D. THOMPSON, formerly superintendent of the L. O. Gordon Manufacturing Company, of Muskegon, Mich., has resigned and taken charge of the engineering and sales department of the Charles A. Strelinger Company, Detroit, Mich.

JOHN K. RECKENDORFER, formerly assistant secretary of the American Lead Pencil Company, New York, has become associated with the Naval Aircraft Factory, Navy Yard, Philadelphia, Pa., in the capacity of assistant to manager.

FRANCIS L. GILMAN has severed his connection with the Western Electric Company, New York, as assistant chief engineer, to take charge of the manufacturing departments of the National Conduit and Cable Company, Hastings-on-the-Hudson, N. Y.

F. J. BRYANT, formerly affiliated with the Huber Hand Stoker Company, Passaic, N. J., in the capacity of New Jersey manager, has become partner in the firm of the Perfection Toy Craft Company, of West Brookfield, Mass.

RALPH EARL, until recently with the Pittsburgh Filter Manufacturing Company, Pittsburgh, Pa., has become associated with Morris Knowles, Inc., of the same city.

JOHN D. ROGERS has left the employ of the Virginia Railway Company, Princeton, West Va., to accept service in Russia.

GEORGE ENDICOTT, for two and a half years mechanical engineer at The Morgan Spring Company, Worcester, Mass., has resigned to accept a position in the sales department of the Wickwire Steel Company, of Buffalo, N. Y. He will take up his new duties January 1, and will make his headquarters in Buffalo, N. Y.

K. T. KELLER, until recently master mechanic with the Cole Motor Car Company, Indianapolis, Ind., has become affiliated with the Buick Motor Company, of Flint, Mich.

L. H. THULLEN, formerly in the employ of the Hall Switch and Signal Company, New York, has assumed the duties of general manager of the Grand Rapids Brass Company, Grand Rapids, Mich.

ALLEN C. STALEY has severed his connection with the General Engineering Company, of Detroit, Mich., where he held the position of experimental engineer in charge of development work on the Doble steam car, and has become associated with the Stanley Motor Carriage Company, Newton, Mass., as research engineer in the same line of work.

## ANNOUNCEMENTS

PARKER H. KEMBLE has entered the Sea Service Bureau at the National headquarters of Henry Howard, director of recruiting for the United States Shipping Board at the Boston Customhouse, for the duration of the war.

GEORGE E. CROFOOT has been promoted from instructor to assistant professor of mechanical engineering in the Towne Scientific School of the University of Pennsylvania, Philadelphia, Pa.

JOHN H. DEVISSER, of Detroit, Mich., has taken up his duties as Captain in the Ordnance Department and is at present stationed at the Frankford Arsenal, Philadelphia, Pa.

CLAYTON R. BURT, assistant general manager of the Russell Motor Car Company, Ltd., Toronto, Canada, has accepted a position as general manager of the same company, at Buffalo, N. Y., where a large new factory for the manufacturing of munitions for the U. S. Navy Department is being established by the company.

MONROE R. HULL, mechanical engineer for the Sissert Mining District Company, of London and Petrograd, has recently returned from Russia and will spend several months in the United States in the interests of the Sissert Company.

FREDERICK POPE, of Moses, Pope and Messer, Inc., consulting engineers, New York, has been commissioned a Captain in the 30th Engineers, which is the Gas and Flame Division.

C. P. COLEMAN, vice-president of the Worthington Pump and Machinery Corporation, has recently been elected president of the corporation.

CHANNING TURNER has received a commission as First Lieutenant, Field Artillery, Officers Reserve Corps, and has been ordered on active duty.

L. RICHARD DRESSLER has received a commission as First Lieutenant in the Ordnance Department, Carriage Division, Officers' Reserve Corps.

L. H. BERGMAN, formerly fuel engineer for the Nicetown Plant of the Midvale Steel and Ordnance Co., has gone into consulting practice under the name of American Industrial Engineering Co., with offices in the Monadnock Building, Chicago.

FRED L. PANCOAST has received a commission as Captain in the Ordnance Department, Officers' Reserve Corps, and has been assigned to active service.

FRANK P. RHAME has been commissioned as First Lieutenant in the Ordnance Officers' Reserve Corps.

CHARLES DAY has now returned from England and will assume active management of the probation department of the Emergency Fleet Corporation.

SANFORD E. THOMPSON, of Thompson and Lichtner, consulting engineers, Boston, Mass., has accepted a commission as major in the Ordnance Department, Officers' Reserve Corps. Mr. William O. Lichtner will carry on the work of the company.

J. G. SCRUGHAM has been commissioned as Major, Ordnance Reserve Corps, and assigned for duty to the Production Section, Carriage Division, Ordnance Department, Washington, D. C.

C. L. HALLADAY, of Jackson, Mich., has become associated with the Auto Industries Committee, of Washington, D. C.

ELMER R. RITTER has entered into active service as a First Lieutenant in the United States Ordnance Reserve.

KEPPELE HALL, of the firm of Thompson and Lichtner, consulting engineers, of Boston, has accepted a commission as Captain in the Ordnance Department and is now located at Washington, D. C.

MAJOR DABNEY H. MAURY, Engineer Officers' Reserve Corps, has closed his office in Chicago for the duration of the war. For some time past he has been in Washington looking after water-supply problems in connection with cantonment construction.

W. E. MOSHER has been appointed by the Secretary of War as assistant superintendent engineer in connection with Marine Refrigeration, Army Transport Service, Quartermaster Corps, U. S. A. Piers, at Hoboken, N. J.

MAJOR-GENERAL GEORGE W. GOETHALS, acting quartermaster general, has been appointed by the Secretary of War to serve also as director of War Department transportation and storage.

# NECROLOGY

## WILLIAM CHARLES ADAMS

William C. Adams was born in April 1883 in North East, Erie County, Pa. He was educated in the schools there and later attended the State Normal School. He also took a course in the International Correspondence Schools.

He served his apprenticeship as machinist with the Eureka Tempered Copper Works, North East Pa., from 1902 to 1903. He then located with the Brooks Locomotive Works, Dunkirk, N. Y., as machinist. In 1904 he became associated with the Bantam Anti-Friction Co., Bantam, Conn., as draftsman, and a little later worked in the same capacity for the Coe Brass Manufacturing Co., Torrington, Conn. In 1905 he returned to the Bantam Company as superintendent. In 1908 he took charge of the sewer works of the city of Torrington.

From 1909 until 1914 Mr. Adams was employed by the Chase Rolling Mill Co. and the Chase Metal Works Co., Waterbury, Con., as draftsman and engineer, and designed, constructed and maintained their hydraulic extrusion and rolling-mill machinery. Until the completion of the new plant of the Chase Metal Works Co. Mr. Adams had charge of the machine shop, drafting room, pattern shops and hydraulic plant of the Chase Rolling Mill Co. He took charge of the same departments in the new plant.

About March 1915 Mr. Adams became associated with the Kings Norton Metal Co., Ltd., Kings Norton, Birmingham, England, as works manager. He designed and superintended the erection of buildings and plant for the extrusion of non-ferrous metals in bars and sections. As a single unit the plant is regarded by experts as the largest and finest in the British Isles.

Mr. Adams was a member of the Birmingham Association of Mechanical Engineers, the Institute of Metals, London, and was honorary treasurer of the Birmingham Metallurgical Society. He became a member of the Society in 1914. He died on July 13, 1917.

## ADOLPH THEODORE BRUEGEL

A. Theodore Bruegel, secretary of the Hess-Bright Manufacturing Co., Philadelphia, died at his home in Melrose Park on November 7, 1917. Mr. Bruegel was born on January 11, 1866, in Canton, O. He was educated in the St. Louis Manual Training School and later attended Lehigh University, being graduated in 1888 with the degree of M.E. He took a post-graduate course in Cornell University and received his M.M.E. degree in 1896.

During the summers of 1883 to 1885 he worked as machinist for the Missouri Malleable Iron Works and the Lehigh Valley Railroad Co. He obtained his drafting-room experience with the Johnson Steel Co., Johnstown, Pa. From 1888 to 1892 he acted as instructor in mechanical drawing and descriptive geometry in Cogswell Polytechnic College, San Francisco. For the next five years or so he was connected with Sibley College, Cornell University, as instructor in machine design. Later he took charge of the teaching of kinematics of machinery and also junior drawing.

In 1898 Mr. Bruegel became an instructor in mechanical engineering in Pratt Institute, Brooklyn, giving his attention principally to the steam and machine-design courses. For the last ten years he was associated with the Hess-Bright Manufacturing Co., Philadelphia.

He was a member of the Engineers' Club of Philadelphia, the Society for the Promotion of Engineering Education, the American Association for the Advancement of Science, the National Geographic Society, and the Philadelphia Chamber of Commerce. He became a member of the Society in 1900.

## JOSEPH PHINEAS DAVIS

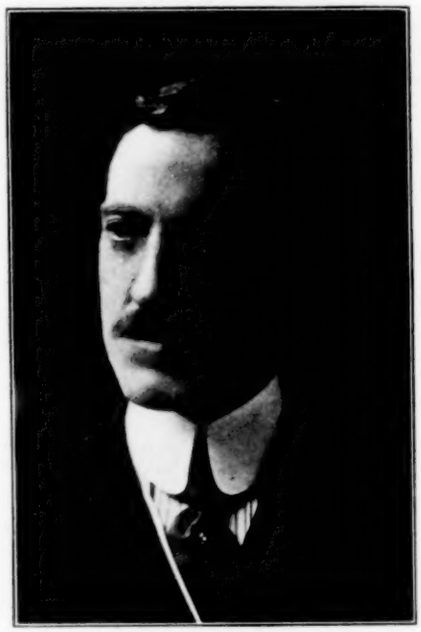
Joseph P. Davis was born on April 15, 1837, at Northboro, Mass. He was graduated from Rensselaer Polytechnic Institute in 1856 with the degree of C.E. Until 1861 he acted as assistant engineer on the construction of the Brooklyn Water Works. He then went to Peru, S. A., where he remained for four years in the employ of the government as topographical engineer. Upon his return he was made commissioner of parks in Brooklyn, N. Y.

About 1867 he was appointed chief assistant engineer on the construction of the St. Louis Water Works, later becoming chief engineer on the construction of the Lowell, Mass., Water Works. In 1872 he was appointed chief engineer of the Boston Water Board, and the following year was made city engineer of Boston, which position he held till 1880.

At that time Mr. Davis accepted a position with the American Bell Telephone Co. as chief engineer, holding the same position with its successor, the American Telephone and Telegraph Co., until 1905, when he retired from active business.

Mr. Davis was the consulting engineer of the Croton Aqueduct Commission from 1884 to 1886, of the Massachusetts State Board of Health from 1886 to 1904, of the Metropolitan Sewerage Commission, Mass., in 1898. He was vice-president and general manager of the Metropolitan Telephone Co., New York, from 1880 to 1886, and was president of the Hudson River Telephone Co. from 1889 to 1895, and of the Westchester Telephone Co. from 1890 to 1903.

Mr. Davis was a member of the American Society of Civil Engineers, the American Institute of Electrical Engineers, the



A. T. BRUEGEL

Institution of Electrical Engineers, England, and the Boston Society of Civil Engineers. He became a member of the Society in 1880. He died on March 31, 1917.

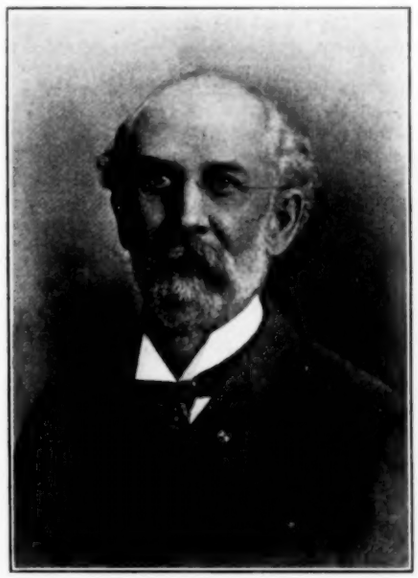
## AUGUST A. HONSBERG

August A. Honsberg was born on May 18, 1841, in Boulay, Metz, France. He was educated in France, receiving his technical training in the Institution Carmentrez.

He served an apprenticeship from 1859 to 1861 with Kaut & Westmayer at St. Jean, Saarbrucken, Germany. The next two years he spent at the Ateliers des Chemins de Fer de l'Est, Montigny. He obtained his drafting experience from 1863 to 1865 in the Regimental School of Engineers, leaving there to go to l'Ecole Polytechnique, Metz. In 1886 he became superintendent of machinery at the Arsenal, Genie. He served during the Franco-Prussian War as chief of the engineering detachment, Fifth Army Corps.

About 1872 Mr. Honsberg came to the United States. His first position was with the Kings Bridge Co. Later he was associated with the Keystone Bridge Co. In 1881 he became master mechanic in charge of machinery and buildings of the Cleveland Rolling Mill Co. After ten years' service he resigned to take a position in the Cleveland city engineer's office in the bridge department, leaving this department after another ten years to enter the city water works office, to make plans for a new pumping station, engine and boiler house. For the last six years he was connected with the bridge and map department of the city of Cleveland.

Mr. Honsberg became a life member of the Society in 1901. He



JOSEPH MORGAN, JR.

was also a member of the Cleveland Engineers' Society. He died on October 21, 1917.

## GUY EDWARD MITCHELL

Guy E. Mitchell was born on March 4, 1869, in Lowell, Mass. He attended the public schools of that city and later entered the Massachusetts Institute of Technology, from which he was graduated as a mechanical engineer in 1891.

He was employed for a number of years by the Boston and Maine Railroad and worked up from the position of chief draftsman to that of consulting engineer of that company. After leaving the Boston and Maine Railroad he was located in New York for about three years as consulting engineer. He then served in various important capacities in the building of the Berkshire trolley system. Upon the completion of that work he became associated with the Alden Sampson Co., Pittsfield, builders of large automobile trucks, and acted as general manager for a period of seven years. Later he assisted in the building of the Hampden Railroad.

In December 1914 he was appointed manager of the municipal gas and electric light plant, Westfield, Mass. He held this position at the time of his death.

He became a member of the Society in 1903. He died on October 18, 1917.

## JOSEPH MORGAN, JR.

Joseph Morgan, Jr., was born on July 27, 1842, in Philadelphia. He was educated in the Central High School of that city, devoting himself to the sciences. In the fourth year of his course he entered the steam-engineering corps of the United States Navy. In 1861 he entered active service as third assistant engineer. In 1863 he was promoted to second assistant engineer. In 1866,

after the war, he resigned and entered the service of the Phenix Iron Co., Phenixville, Pa., as draftsman. In 1868 he had risen to be chief draftsman, when he resigned to take a similar position with the Edgemoor Iron Co. About 1879 Mr. Morgan became associated with the Cambria Iron Co., Johnstown, Pa., as draftsman. He was made chief engineer in 1881, and after twenty-five years' service in that capacity was relieved of his more active duties and made consulting engineer of the Cambria Steel Co.

Mr. Morgan designed and superintended the various parts of the works of that firm, including six blast furnaces, new bessemer works of the largest class, new blooming mill, open-hearth plant, rail mills and various large mills of the Gautier plant involving the expenditure of millions of dollars. He was the consulting engineer in charge of the building of the Quemahoning Dam in 1913, and later the Saltlick Dam.

In 1884 Mr. Morgan went abroad to make a study of gun and armor forgings. He visited the principal cities of England and the Continent where armor-making works were located. Later he was appointed a member of the United States Fortification Board, and wrote several valuable papers to aid in instructing the public on the subject, as well as for the information of Congress. Mr. Morgan was familiar with the art of steel making from the date of the inception of the bessemer process up to the present time.

Mr. Morgan was a member of the United States Naval Institute and the Grand Army of the Republic and also held many offices in fraternal organizations. He was vice-president of the Society from 1886 to 1888 and was chairman of the Sub-Committee on Iron and Steel for the year 1913-14. He became a life member of the Society in 1881. He died on December 9, 1917.

## JOHN RIDDELL

John Riddell, mechanical superintendent of the Schenectady Works of the General Electric Company, died in Schenectady, N. Y., December 31, 1917. He was born in Ireland in 1852 and was conspicuously a self-made man. At the age of about 13 years, in Jersey City, he started as an apprentice in the jobbing machine shop of Nicholas B. Cushing, who made elevators and repaired machinery, especially marine engines. This work brought him in contact with marine circles, which resulted in his later serving two years as second engineer on trading steamers plying between the West Indies and Central America and New York.

His first association with the electrical business was with the Daft Electrical Co. where he did considerable experimental mechanical work in the railway field. In 1887 he entered the employ of the Thomson-Houston Electric Co. at Lynn, Mass. In 1888 he became foreman of the railway motor shop and was recognized as one of the leading mechanical experts at the time the General Electric Co. was formed in 1892.

Mr. Riddell moved to Schenectady in 1895, and shortly after his arrival was appointed mechanical superintendent of the company. In this important position he designed and had built special machine tools for increasing the production of the machine shops and also for carrying on the many special processes involved in the manufacture of mechanical tools. He was consulted in regard to all automatic machinery and his resourceful genius was called in when a solution was sought for different mechanical problems of a baffling nature. The records of the United States Patent Office show that 37 patents were taken out in his name.

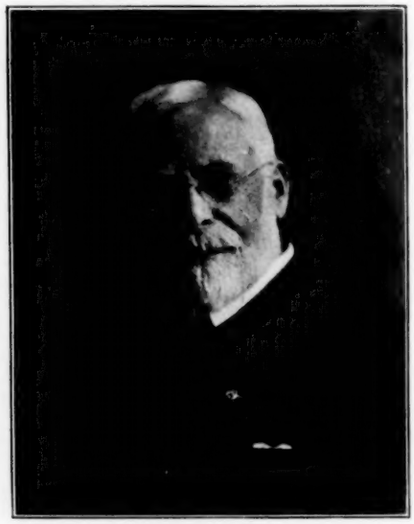
In the sense that Mr. Riddell could obtain large outputs from machine shops with a minimum cost, he might well be termed a manufacturing economist. He was responsible for the location of machines and machine tools and his advice and opinion were sought in regard to such manufacturing problems as the routing of the materials from the time the raw materials were received until the finished product was ready for shipment.

Among the notable achievements of Mr. Riddell in the various works of the General Electric Co. is a boring mill—the largest in the world when made—which was built from his design and which has a 60-ft. swing. This was so successful for machining the large wheels for the rotors and stators of water-wheel-driven generators that he designed a 40-ft. boring mill embodying the same principles as the large one, which is used for turbine work. These mills have operated night and day for over ten years without the loss of a single hour.

Another one of his designs was a bucket-cutting machine for large steam turbines which he developed in 1902. It was at this time that the General Electric Co. was building the first 5000-kw. steam turbine ever constructed, and this labor- and time-saving device became an important factor in the development of the steam-turbine industry at the time when the steam engine was preëminent in the largest power plants in the world.

Almost automatic was the field-coil-winding machine which he built and which was adopted both in Lynn and Schenectady. It was a labor saver and a time saver, and in the opinion of many persons there was no single achievement of Mr. Riddell's which advanced the electrical industry more than did this winding machine.

Mr. Riddell was a member of the Engineers' Club of New York and the Society of Engineers of Eastern New York. He became a member of the Society in 1895. During his later years he delivered several papers on engineering subjects before various associations.



JOHN RIDDELL

He was awarded a gold medal at the Panama-Pacific International Exposition at San Francisco in 1915, as collaborator in the Exhibit of the General Electric Co. at the Exposition.

## HAROLD VAN DUZEE

Harold Van Duzee was born in West Newton, Mass., on April 4, 1859. He attended the public schools of that city and later entered the engineering department of the Massachusetts Institute of Technology. He spent one year in miscellaneous drafting work for Frederick Tudor & Co. and for the Hinkley Locomotive Works, both of Boston, Mass. For two years he was associated with Col. George E. Waring of Newport, R. I., as draftsman and was his assistant on sewage and drainage work in Memphis, Tenn., where he remained for about a year. The second year of this work he had charge of the sewage disposal of the Bryn Mawr Hotel. His next position was with the Tide Water Oil Co., Bayonne, N. J. At the time of his death Mr. Van Duzee was in private practice in Philadelphia as a civil and sanitary consulting engineer.

Mr. Van Duzee did much to beautify the suburban homes of Philadelphia, working in this connection with the Olmstead Bros. of Brookline, Mass. He also collaborated with Mr. F. W. Taylor in the scientific development of sod for golf grounds.

He became a Junior member of the Society in 1885. He died on May 7, 1917.

## WILLIAM FORGUE WAY

William F. Way was born on October 3, 1888, in Johnstown, N. Y. He was graduated from Rensselaer Polytechnic Institute in June 1913 with the degree of mechanical engineer. His shop experience was obtained in Hutton's Machine Shop, Seattle, Wash. Later he became associated with the Talbot Boiler Co., Seattle, as draftsman. He became a Junior member of the Society in 1916. He died on December 18, 1916.

# CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER MARCH 10

BELOW is the list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of new applications, 112.

*The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted.* All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by March 10, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about April 15.

*NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.*

## NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

**California**

PITTS, HAROLD P., Industrial Engineer, Pacific Gas & Electric Co., San Francisco

**Colorado**

ORR, CARLETON A., Superintendent Power Plants and Shops, Arkansas Valley Railway, Light & Power Co., Pueblo

**Connecticut**

AVIS, SAMUEL W., Mechanical Engineer, Hartford Special Machinery Co., Hartford

BRITTAN, FREDERICK A., Engineer, Remington Arms & Ammunition Co., Bridgeport

TOMS, ROLLIN T., Foreman Stock Tool Department, Yale & Towne Mfg. Co., Stamford

**District of Columbia**

BARRETT, CHARLES G., Assistant Engineer, U. S. Shipping Board, Emergency Fleet Corp.

BASCOMBE, FRANK J., Assistant Superintendent, Washington Steel & Ordnance Co.

BLACK, JOHN S., Captain Ordnance Reserve Corps, U. S. A.

MARTIN, H. T., Captain Ordnance Reserve Corps, U. S. A.

**Delaware**

MAGUIRE, CHARLES F., Design Engineer, E. I. du Pont de Nemours & Co., Wilmington

**Illinois**

CAREY, JAMES L., Architect and Engineer, Chicago

PEACH, WILLIAM M., Chief Draftsman, Pullman Mfg. Co., Pullman

STUART, WILLIAM K., Assistant Secretary, Western Steel & Fdy. Co., Chicago

**Indiana**

CRAVENS, GEORGE W., Chief Engineer and Works Manager, Elkhart Carriage & Motor Car Co., Elkhart

**Kentucky**

ANDERSON, WARWICK M., Professor of Physics, University of Louisville, Louisville

**Louisiana**

DOBREE, BASIL S. T., Chief Engineer, Panama Ice Co., New Orleans

**Maryland**

HIND, THOMAS W., Consulting Engineer, The Crown Cork & Seal Co., Baltimore

**Michigan**

LINK, VINCENT, Consulting Engineer, Studebaker Corp., Detroit

**Minnesota**

BOOTH, GEORGE, Works Managing Engineer, Pan Motor Co., Saint Cloud

REES, ELIAS, Fuel Engineer, C. L. Pillsbury Co., Minneapolis

ZIMMERMAN, FRANK R., Chief Engineer, National Iron Co., Duluth

**Missouri**

CANAVAN, ASA L., Southwestern Representative, W. H. Miner, Grover

TALEN, MAURITZ W., Chief Draftsman, The Ruemmeli-Dawley Mfg. Co., St. Louis

TOENSFELDT, KURT, Principal Assistant Mechanical Engineer, St. Louis Water Works, St. Louis

**New Hampshire**

CUMMINGS, FRED A., Resident Engineer, Nashua Mfg. Co., Nashua

**New Jersey**

CARLTON, JOSEPH R., Mechanical Testing, Public Service Electric Co., Newark

SCHEEL, JOHN B., Production Manager, New Jersey Brass Corp., Garfield

**New York**

BASTIAN, FREDERICK G., Mechanical Foreman, Lackawanna Steel Co., Lackawanna

BEEBEE, LEWIS, Mechanical Engineer, Hammond Steel Co., Inc., Syracuse

COCHRANE, LEWIS, Chief Engineer, New York *Times*, New York

GRONBECH, CHRISTIAN E. A., Superintendent and Assistant Factory Manager, C. J. Tagliabue Mfg. Co., Brooklyn

HULST, JOHN, Assistant to Vice-President, and Chief Engineer, United States Steel Corp., New York

KAY, GEORGE A., with E. W. Bliss Co., Brooklyn

KIRKHAM, CHARLES B., Chief Designing Engineer, Curtiss Aeroplane & Motor Corp., Buffalo

MORSE, EDWARD P., Jr., General Superintendent, Morse Dry Dock & Repair Co., Brooklyn

PEET, EDWIN B., Mechanical Engineer, E. W. Bliss Co., Brooklyn.

STARK, ARTHUR W., Assistant to Engineer of Construction, Consolidated Gas Co. of N. Y., New York

TAGGART, JAMES M., Consulting Engineer, Engineering Department, Interborough Rapid Transit Co., New York

WALSH, GEORGE. W., Mechanical Engineer, C. E. Knoeppel & Co., New York

**Ohio**

BAILY, THADDEUS F., President, The Electric Furnace Co. of America, Alliance

TUECHTER, AUGUST H., President, The Cincinnati Bickford Tool Co., Cincinnati

YANNEY, GEORGE W., Chief Draftsman, Alliance Machine Co., Alliance

**Oklahoma**

MEYER, BARNEY, Mechanical Superintendent, Cosden & Co., Tulsa

**Oregon**

DICKSON, JOHN, Superintendent Motive Power, Spokane, Portland & Seattle Rwy., Oregon Electric Rwy., and Spokane & Inland Empire Rwy., Portland

**Pennsylvania**

GILDERSLEEVE, FRANK M., Assistant Mechanical Engineer, Ridgway Dynamo & Engine Co., Ridgway

KAVANAUGH, RAMSEY D., Foreman of Road Tests, Pennsylvania R. R. Co., Altoona

RAPP, JESSE P., Chief Inspector, Purchasing Department, American International Shipbuilding Corp., Philadelphia

SUPPLEE, WARREN P., Chief Operating Engineer of Power Stations, The Eastern Penn. Light, Heat & Power Co., Pottsville

**Rhode Island**

SWASEY, CORNELIUS B., Superintendent, Allens Ave. Plant, Gorham Mfg. Co., Providence

**Tennessee**

ROBINSON, G. A., Mechanical Superintendent, La Follette Coal & Iron Co., La Follette

**Texas**

LEARMONTH, ALEXANDER C., Chief Engineer Power Plant, El Paso Electric Rwy. Co., El Paso

**Virginia**

DAVIS, GEORGE M., Locomotive Designer, Norfolk & Western Rwy. Co., Roanoke

HIGGINS, EDMUND S., 2nd Assistant Manager, Hopewell Works, Du Pont Powder Co., City Point

LEPS, HENRY M., Lieutenant (j.g.), U.S.F.N.R., Engineering Assistant, Office of Aide for Material, Norfolk

**Wisconsin**

BRINTZINGER, CHARLES H., Appraisal Engineer, American Appraisal Co., Milwaukee

**Wyoming**

BRENNAN, WILLIAM D., Assistant General Manager, The Union Pacific Coal Co., Cheyenne

**Canada**

CARPENTER, FRANK G., Superintendent Plant and Chief of Construction and Engineering, P. Burns & Co., Ltd., Calgary

**Cuba**

GOIRIGOLZARRI, MANUEL, Manager, Havana Marine Railways, Inc., Havana

**China**

HOPKINS, R. D., with the China-American Trading Co., Inc., Tientsin

**Norway**

BASSOE, CARL F., Engineer, Norsk Aluminum Co., Kristiania

**Japan**

TAKETA, HIDEJI, Mechanical Engineer, Ashio Mines of Furukawa Mining Co., Shimotsuke

**South America**

MACWHIRTER, GEORGE E., Operating and Constructing Engineer, Boquete Nitrate Co., Antofagasta, Chile

ANSALDO, PEDRO, Chief Engineer and General Manager, De La Compania Industrial De Electricidad, Buenos-Aires, Argentina

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

**Alabama**

EPHGRAVE, HERBERT, Chief Engineer, Joubert & Goslin Machinery & Fdy. Co., Birmingham

**Connecticut**

LANNON, JOHN D., Assistant Superintendent of Manufacturing, Remington Arms-U. M. C. Co., Bridgeport

**Indiana**

SUTLIFF, JAMES T., Advertising Manager, The Connersville Blower Co., Connersville

**Maine**

ROWE, LOUIS G., Production Engineer, Eastern Mfg. Co., South Brewer

**Michigan**

WATSON, HARRY J., Instructor in Mechanical Engineering, University of Michigan, Ann Arbor

**New Jersey**

KELLEY, JOSEPH A., Designer Special Machinery, Edison Storage Battery Co., Orange

**New York**

AKERLY, HAROLD E., Industrial Engineer, Eastman Kodak Co., Rochester

BLOMGREN, HERBERT, Assistant Engineer, Westinghouse, Church, Kerr & Co., New York

**Washington**

BUCKINGHAM, JAY E. E., Assistant General Manager, Hofius Steel & Equipment Co., Seattle

**Wisconsin**

KOSKINEN, EINAR T., Draftsman, Nordberg Mfg. Co., Milwaukee

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

**Illinois**

CUNNINGHAM, JAMES D., President, Republic Flow Meters Co., Chicago

KELLY, ROY C., Chief Engineer, Moline Pressed Steel Co., Moline

PRATT, JABEZ H., Chemical Engineer, The Liquid Carbonic Co., Chicago

**Indiana**

SAUNDERS, FRED S., Charge of Planning Department, Diamond Chain Mfg. Co., Indianapolis

**Massachusetts**

BOSWORTH, RALPH L., Designing Engineer, Crocker-McElwain Co., Holyoke

McKECHNIE, ALEXANDER B., Sales Engineer, The Merrill Process Co., Boston

**New Jersey**

SMITH, CHESTER F., Assistant Superintendent, Case & Can Department, Standard Oil Co., Bayonne

STENKEN, HARRY A., Assistant Engineer, American Sugar Refining Co., Jersey City

**New York**

MITCHILL, GEORGE L., Chief Inspector, Electric Bond & Share Co., New York City

UNDERHILL, JACOB, Inspector of the Contract & Inspection Department, New York Edison Co., New York City

**Pennsylvania**

ALLEN, EDWARD G., Marine Engineer and Supervising Draftsman, Philadelphia Navy Yard, Philadelphia

BATTLE, JOHN R., Mechanical Engineer and Philadelphia Manager, Swan & Finch Co. of New York, Philadelphia

PETERS, FRANCIS C., Mechanical Engineer, The New Jersey Zinc Co., Palmerton

TAFEL, THEODORE, Jr., Standard Sanitary Mfg. Co., Pittsburgh

FOR CONSIDERATION AS JUNIOR

**California**

DUNCAN, GEORGE W., Jr., Consulting Mechanical Engineer, San Francisco

**Connecticut**

BENSON, CARL N., Mechanical Draftsman, S. K. F. Ball Bearing Co., Hartford

STOCKMANN, ERLING B., Inspector of Ballistics, Remington Arms-U. M. C. Co., Bridgeport

**District of Columbia**

ANDRAE, WILLIAM C., Laboratory Assistant, Bureau of Standards.

HARTMAN, CLARENCE O., Draftsman, Ord. Dept., Field Carriage Div.

SEARLE, RUSSELL M., Draftsman, Gun Division, Ordnance Bureau, U. S. A.

**Florida**

BOEHNLEIN, CHARLES, Aeronautic Draftsman, Naval Air Station, Hull Drafting Department, Pensacola

**Massachusetts**

JOHNSON, HAROLD S., Erecting Engineer, Westinghouse Electric & Mfg. Co., Boston

McNALLY, EDWIN M., Cadet, U. S. Naval Reserve Flying Corps, Bureau Steam Engineering Naval Aviation Detachment, Mass. Inst. of Tech., Cambridge

**Michigan**

HELLER, LEWIS W., Graduate Student, University of Michigan, Ann Arbor

**New Jersey**

BROWN, J. LYALL, Mechanical Designer, Crocker-Wheeler Co., Ampere

TERRY, CARLYLE M., Assistant Engineer Power House, Babcock & Wilcox Co., Bayonne

**New York**

CROCKETT, CHARLES H., Research Engineer, Troy

BRUMBLE, WILLIAM C., Mechanical Draftsman and Engineering Assistant, New York Central Railroad, New York City

GORDON, MERRITT W., Cadet Engineer, Fulton County Gas & Electric Co., Gloversville

MARKLEY, WILLIAM F., Engineer, Western Union Telephone Co., New York City

NAUMANN, WILLIAM H., Chief Inspector U. S. Government, Artillery Ammunition, Inspection Section Ordnance Department, New York City

SPELLMAN, CHARLES B., Draftsman, Niagara, Lockport & Ontario Power Co., Lyons

**Ohio**

INDERBITZIN, ALEXANDER M., Mechanical Engineer, East Iron & Machine Co., Lima

SHIRLEY, HARVEY J., Machine-Tool Designer and Checker of Design, Lodge & Shipley Machine Tool Co., Cincinnati

**Oklahoma**

HOFFMAN, RAY T., Construction Engineer, Sapulpa Electric Co., Sapulpa

**Pennsylvania**

HOFFER, HOWARD A., Engineer, Special Castings Department, U. S. Cast Iron Pipe & Fdy. Co., Philadelphia

MAGOUN, JOHN W., Assistant Engineer of Tests, Steelton Plant, Bethlehem Steel Co., Steelton

**Vermont**

BRILL, ELLIOT M., Manager Cost Dept., Jones & Lamson Machine Co., Springfield

**China**

GREENWOOD, HEMAN C., Chief Instructor of Mechanical Engineering, Hunan Polytechnic Institute, Changsha

## APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

**New York**

ROGERS, FRED E., Editor *Machinery*, New York

PROMOTION FROM ASSOCIATE-MEMBER

**Massachusetts**

GUNNING, WILLIAM A., Head Draftsman, American Optical Co., Southbridge

**New York**

BORIE, RENSHAW, Engineer Hoist Department, The Yale & Towne Mfg. Co., New York

PROMOTION FROM JUNIOR

**Illinois**

BRYEN, THOMAS T., with Williams, White & Co., Chicago (Reinstatement)

**New York**

FLAGG, SAMUEL B., Fuel Expert, Electric Bond & Share Co., New York

WANDEL, CARLETON, Lumber Salesman, with C. H. Pearson, New York

WEBER, H. F., with Compression Engineering Corp., New York

### SUMMARY

| | |
|---|---|
| New applications | 112 |
| Applications for change of grading: | |
| Promotion from Associate | 1 |
| Promotion from Associate-Member | 2 |
| Promotion from Junior | 4 |
| Total | 119 |

# EMPLOYMENT BULLETIN

***THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.***

*IN forwarding applications, stamps should be enclosed for transmittal to advertisers; applications of non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society.*

## GOVERNMENT REQUESTS

*The Society has been asked to make suggestions of men for the following positions with the Government. Non-members possessing the necessary qualifications may avail themselves of these notices by enclosing with their reply a personal introduction to the Secretary. Kindly advise this office what action you have taken.*

MEN competent to take over the maintenance and supply work for aero squadrons. Those qualifying must be over the draft age, but in cases of exceptional ability commissions will be issued to those in the draft age. 2574.

INSPECTION MEN FOR AERONAUTICAL ENGINES. 2575.

ENGINEERS FOR REPAIR STATION for the vessels of this Service in a port of France. Men to serve in a military or civilian capacity. Commissions in the U. S. Officers' Reserve Corps, and consideration may also be given to applicants within draft age. 2580.

INSPECTION MEN ON CARTRIDGES. Those above draft age and who show high qualifications will be commissioned. 2581.

DESIGNERS AND CONSTRUCTION ENGINEERS, mechanical and civil. 2564.

ASSISTANT GENERAL SUPERINTENDENT for woodworking and ironworking plant employing 3000 men. Age 30 to 40 years. Technical education required, with five or more years' practical experience in handling men. Location Indiana. 2566.

TIME-STUDY MAN for small manufacturer making small stampings and brass goods. Should be conversant with modern cost accounting and able to make correct cost estimates. Location Michigan. 2567.

WORKS MANAGER. Must be familiar with the handling of help and the manufacture of small tools such as taps and dies. Young man preferred. Location Massachusetts. 2571.

JIG AND SMALL-TOOL DESIGNER, good on experimental work on steam specialties; eventually to head engineering department. Location New York City. 2572(a).

TIME-STUDY MEN. Two to four high-grade men desired. 2572(b).

MECHANICAL ENGINEER to take charge of the entire mechanical end of business, in a new position created by the growth of company in New England States. Man of more than ordinary ability. Salary $4000 to $6000 at the start. 01.

MASTER MECHANIC for large central power plant. Permanent position with chance for advancement. State age, experience, salary expected and position regarding draft. 04.

YOUNG MAN with school education at least and preferably with one or more years in college, probably not subject to draft, to enter engineering organization at nominal salary. Chance for advancement will depend upon ability of applicant. Experience along sugar-machinery lines of considerable assistance. Location New York City. 012.

GENERAL MANAGER for an old established Chicago plant manufacturing light and heavy machinery, special tools, etc. Man of 45 to 55 years of age preferred. Location Illinois. 07.

MECHANICAL DRAFTSMAN. Salary $20 to $25. Location New York. 09.

FIRST-CLASS DRAFTSMAN experienced on heavy engines and accustomed to handling work with only general supervision; also good detailers. Give full particulars in first letter. Location Ohio. 011.

## POSITIONS AVAILABLE

SALES ENGINEER. Young engineer, to sell and supervise installation of steam traps and temperature regulators. Steady promotion offered. 2483.

CHIEF ENGINEER versed in refrigeration and producer-gas-engine work. Salary $2400 to $3000. Location, 50 miles from Baltimore. 2488(a).

SIX MEN to operate anthracite gas producers. Salary $21 a week, eight-hour shift. 2488(b).

TURBINE OPERATING ENGINEERS, high-class. Two or three young men with good education and some practical experience. 2492(a).

SWITCHBOARD OPERATORS who have had experience in large stations. Two or three, preferably, young men with good education to qualify for responsible positions on this line of work. 2492(b).

YOUNG TECHNICAL GRADUATE in mechanical engineering with four or five years' factory experience for position of assistant engineer. Good opportunity for advancement. 2501.

OPERATING ENGINEER for industrial plant located near Chicago. Must be a technical graduate and have had practical operating experience in power plants, and be capable of handling a power proposition involving approximately 5000 boiler hp. State age, experience in detail, and salary expected. 2445.

COLLEGE GRADUATES, ENGINEERS. Men out at least a year, for general shop engineering work with growing concern. Work leads to industrial management. State full particulars. 2478.

ELECTRICAL ENGINEER for plant in northern Ohio. Must assume (1) full charge of all electrical layout work, (2) supervise purchase of all electrical material and equipment, (3) act in an advisory capacity on all electrical equipment and installations after such have been turned over to the manufacturing departments within the plant, (4) attend to maintenance and upkeep, and (5) assume full charge and supervision of all new electrical installations. 2521.

OPERATING ENGINEERS for munitions plant. Men with practical field experience. Young technical graduates preferred. Salaries from $150 to $200, depending upon men. Positions located in Pennsylvania, Alabama, and Illinois. 2532.

FIRST-CLASS DRAFTSMAN experienced on heavy engines and accustomed to handling work with only general supervision. Give full particulars in first letter. 2533(a).

GOOD DETAILERS. Give full particulars in first letter. 2533(b).

YOUNG TECHNICAL GRADUATE, preferably a mechanical engineer who has had at least a small amount of shop experience, to act as time-study man. Salary to start $125 to $150 per month. Location Connecticut. 2534.

EXPERIENCED DESIGNER on electric baggage-truck work. Work would be the design of two- and four-wheel steer trucks, tractors and trailers. Location New York. 2535.

CHIEF DRAFTSMAN with executive and engineering ability, competent to direct work of large drafting room. Should be technically educated, have knowledge of hydraulic and mechanical engineering and be experienced in surveying and making finished plans of industrial plants. Write, stating nationality, age, education, experience in detail, present responsibilities and salary expected. Excellent opening for a capable, experienced and energetic man. Location Massachusetts. 2539.

TECHNICALLY EDUCATED MEN between 31 and 40 years of age. Three or four wanted for large engineering bureau making inspections of industrial properties. Technical education along mechanical and hydraulic lines important. Good openings for the right men. Give nationality, age, education, experience in detail, and salary expected. Location Massachusetts. 2540.

YOUNG MAN. Technical graduate or man with practical shop experience who is familiar with blueprints and can readily read specifications, to develop as a sales engineer. Sufficient inducements to make the position valuable. Salary proportionate to merit and results. Location New York. 2545.

MECHANICAL ENGINEER for valuation department of chemical plant. Salary $125 to $150 per month. Location New Jersey. 2549.

MEN WITH TECHNICAL EDUCATION AND EXPERIENCE, not subject to military call, for long-established company operating steel and iron foundries and machine and forge shops, whose varied products are sold to the Government, railroads, mining and contracting industries, etc. State full particulars, kind of position preferred and salary expected. Location New Jersey. 2552.

TECHNICAL GRADUATE for fuel-economy work in connection with boiler operation, heating furnaces, and gas producers. Location Pennsylvania. 2559.

HEATING AND VENTILATING ENGINEER to supervise design, installation and work in advisory capacity in connection with maintenance in large rubber factory in northern Ohio. Salary commensurate with training, experience, and ability to handle men. Splendid opportunity for the right man. 2561.

TECHNICAL CORRESPONDENT capable of issuing orders for mechanical work. Location New York. 2562.

MEN EXPERIENCED IN PLANT MAINTENANCE OR SHOP OPERATION for plant-maintenance branch of the Western Electric Company. College education not necessary in all cases provided men have a fairly broad practical experience. Salaries from $1000 to $2000, depending upon qualifications of applicant. Opportunities for advancement for those who possess initiative and ability. 2563.

TOOL DESIGNER who is resourceful and can follow work through to completion. Technical man with practical shop experience. Location Connecticut. 185.

ESTIMATOR for New York concern engaged as engineers and contractors for power plant, ventilation, and steam and hot-water heating. 2103.

CHIEF ENGINEER to take charge of designing of railroad equipment and supplies, including motor cars, hand, push and velocipede cars, and locomotive standpipes. Technical graduate preferred, and as line is highly competitive, a man who can look at matters from a business as well as a strictly engineering point of view. Salary secondary consideration if right man can be secured. Location Middle West. 2247.

CORRESPONDENT for engineering computation department and to handle engineering correspondence, man or woman, preferably a technically educated person. Location Massachusetts. 2284.

YOUNG ENGINEER experienced in general plant construction work. Good opportunities for advancement. Preferably a man who is exempt from military duty. Location Illinois. 2286.

SUPERINTENDENT for machine shop manufacturing high-grade printing machinery. Must be a good executive and thoroughly versed in modern methods of interchangeable manufacturing. Location near New York. Salary depends upon individual. Give age, nationality and complete experience. 2301.

RECENT GRADUATES in mechanical engineering from schools of recognized standing desired for testing work in large steam-operated electric power plants. Applicants with experience in testing work and now located in and around New York City will be given preference. State particulars of education, experience and salary desired. 2345.

ENGINEER familiar with abrasive processes as engineering sales manager with concern manufacturing metal-finishing tools and equipment. Location New York State. 2346.

MECHANICAL DRAFTSMAN OR YOUNG ENGINEER for drafting on refrigerating machinery and installation work. Salary depends upon man. Location New York City. 016.

SALES MANAGER. Engineer experienced in estimating and selling to hold responsible position in long-established engineering and contracting business of an incorporated company, with possible opportunity to become financially interested. State age and experience. 017.

INSTRUCTORS. The Department of Mechanical Engineering, University of Illinois, Urbana, Ill., needs a number of instructors in laboratory work, in machine design, and steam and gas-power engineering. Applicants should send a full statement of their educational training and practical experience with a recent photograph, addressed to Dean C. R. Richards. 018.

## MEN AVAILABLE

EXECUTIVE, SALES ENGINEER, now holding a responsible position as department manager in charge of design and sale of steam specialties, desires similar position with company having larger field and offering better future prospects. Age 35, married. Available on 30 days' notice. Location New York or Philadelphia preferred, but not essential. Minimum salary $4500. B-35.

WORKS MANAGER OR SUPERINTENDENT. Technical graduate; 20 years' experience from foreman to manager; successful executive with experience in modern systems of plant management. Minimum salary $5000. B-36.

EXECUTIVE PURCHASING ENGINEER with successful record in governmental, railroad and industrial service. Experienced in plant design and maintenance, in railroad valuation and in the purchase of electrical, mechanical and structural equipment and materials. At present connected with large corporation completing extraordinary program. B-37.

EXECUTIVE ENGINEER, age 40. Experienced estimator and designer of plants, particularly elevating conveying installations; also experienced in structural-steel and plate work. Willing to invest capital in a plate or machine shop. Size not important but prospects must be good. B-38.

MECHANICAL ENGINEER AND PRODUCTION EXECUTIVE, age 37. Fully trained and practically experienced as tool and die maker, foreman and supervisor of engineering, manufacturing, tool and experimental departments. Well grounded in plant layouts and modern manufacture of interchangeable parts, small, medium and heavy. Knows how to handle men to get coöperation. At present employed but desires change owing to lack of opportunity for future advancement. B-39.

MECHANICAL ENGINEER. Technical graduate with eight years' experience in designing, erecting and operating power-plant and manufacturing equipment. Also experienced in specification and purchase of equipment. Desires position as mechanical superintendent or works engineer. B-40.

CHIEF ENGINEER AND RESEARCH EXPERT with 16 years' practical training in oil- and gas-engine development work. Broad experience in the fine points of both the technical and business side of engineering, with special aptitude for research work and the perfection of new ideas. Thoroughly competent to handle men, and to take charge of the development, design and supervision of construction of either marine or stationary internal-combustion engines. At present employed. Best of references. B-41.

PRODUCTION MANAGER, EFFICIENCY ENGINEER, SUPERINTENDENT OR TOOL ENGINEER. High-grade executive with 15 years' practical and technical experience in manufacturing covering every branch of the business except sales. Expert on tools and equipment, cost methods and time study. Competent to install piece work or bonus system. Until recently efficiency engineer with large automobile company: Business man looking for competent adviser on matters pertaining to manufacturing would find applicant the possessor of an attractive personality and good mixer and diplomat. Salary $3500. B-42.

MECHANICAL ENGINEER. Technical graduate with 20 years' experience in the design, construction and operation of power plants. Also familiar with building construction and the maintenance and operation of large buildings. B-43.

MECHANICAL ENGINEER. Technical graduate, age 25, with three years' experience in varied engineering work, desires position in engineering or engineering sales. Salary $1500. B-44.

PRACTICAL MAN, 42 years of age, with self-acquired technical training, desires position where initiative in labor saving, interchangeability of parts and standardization of methods are needed. Nine years' experience in machine shop, including construction and outside work, 3 years in charge of equipment installation for new plant, 8 years as designing draftsman, and 4 years' office training along industrial-engineering lines. At present employed, but desires opportunity to broaden. B-45.

MECHANICAL ENGINEER. Technical graduate with 7 years' manufacturing experience desires position as assistant-production manager. At present employed in executive position. B-46.

INDUSTRIAL ENGINEER. Technical graduate with two years' experience in time study, cost system, scheduling, planning, etc.; four years as draftsman on heavy machinery, transmission machinery, industrial-plant and power-plant equipment. At present employed but desires change where ability to produce results will be appreciated. B-47.

MECHANICAL ENGINEER. Technical graduate with 12 years' experience in the design and operation of power plants desires a permanent position with reliable concern. Cleveland preferred as location. B-48.

MECHANICAL ENGINEER with technical education and 17 years' experience in the design, construction and operation of industrial plants desires position as mechanical engineer or works manager. Competent to take charge of work from inception to operation of finished plant. Has had experience in organizing and handling work in Spanish-speaking countries and would take position away from home at present if conditions were made sufficiently attractive. B-49.

MECHANICAL ENGINEER who has specialized on drop forgings desires to make a change—reasons on request. Age 32, married, American-born of American parents, absolutely reliable and total abstainer. Desires permanent position with reliable concern. Salary $2500 to $3000. B-50.

FACTORY EXECUTIVE, graduate mechanical engineer, age 39, wishes to connect with progressive concern manufacturing interchangeable parts. Has thorough knowledge and practical experience in scientific-management methods, manufacturing and foundry methods and employment matters. For the last 7 years connected with modern progressive concern as production manager and assistant works manager. Immediately available. B-51.

OPERATING ENGINEER. Associate-member, age 40, with 15 years' experience and 9 years' successful service as chief engineer desires position as chief engineer or superintendent of power with progressive industrial, ore-mining or power company. Good executive. Experience covers steam, electric, producer-gas and Diesel engines, and refrigeration. Location immaterial. At present holding responsible position. B-52.

MECHANICAL ENGINEER of 16 years' experience desires position as general superintendent or production supervisor. Has had extensive experience with modern systems of management, the setting of tasks, piece and bonus rates, routing and scheduling of work and storeroom systems. Has acted as superintendent or organization engineer in the metal-working, textile and paper industries. B-53.

# ENGINEERING SURVEY

## A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

### Corps of Engineers of the U. S. Army

THE war threw open to the Corps of Engineers a tremendous task, especially as compared with its former quite limited activities. In fact, as stated by E. J. Mehren, editor of the *Engineering News-Record*, its purchasing activities have increased 2250 per cent within three months. More than fifty engineer regiments had to be equipped, where only three had been equipped before. The organization had to be built up for handling these increased duties and all of this had to be done at top speed and in a businesslike manner.

In the General Engineer Depot purchases are being handled at present at the rate of more than $1,000,000 a day for every day in the year, with all this immense volume of business concentrated in one office. In fact, it is likely that if the war should continue, probably double that amount will be spent in the succeeding fiscal year.

The work of the General Engineer Depot is very far from being one of a routine character. In the first place, a number of specialist engineer units of a novel character have been authorized, with an equipment far more complex than that of the pioneers of prewar time. Service troops are provided for each special engineer regiment.

Even the equipment for pioneer troops, which has been standardized to a certain extent, had to be modified to fit present needs because of the advance in modern methods of warfare, while for the special regiments all of the equipment had to be selected, readopted or designed anew.

Some idea of the variety of purchasing may be gained from the standard detail supplies of the pioneer regiments alone. These cover more than 300 items and range all the way from pencils to wagons.

Quite frequently the Depot has to handle large orders in which speed is an essential element. Thus standard-gage 90-ton locomotives of a certain type were needed. An order for 300 units was placed on July 19 and on August 11 the first engine was delivered and the order called for completion by October 1.

The purchases, with the exception of some of the equipment of pioneer troops, may be roughly classified into three classes, as follows:

First, such equipment as has been standardized commercially and which without change can be used in military service.

Second, such standard commercial equipment as can by slight changes be adopted for military use.

Third, equipment not used for commercial purposes and which must be designed from the ground up.

The policy of the Depot is to buy commercial equipment whenever possible. It happens, however, that modifications become necessary for military reasons. On the other hand, in other instances, the work of the Depot has clearly disclosed a lack of a standard satisfactory even for commercial use. Thus, it was found that there is no standard rating of gasoline engines and the ratings did not mean the same thing to two different manufacturers, and, in addition, almost without exception, the graded rating was too high.

To expedite its work the practice of the Depot has been to confer with the officials of manufacturing companies from whom it is proposed to purchase, and to insist that the higher officials of the companies be in charge of these negotiations. Manufacturers have found it of advantage to bring with them their engineers and shop superintendents. Discussion with these latter frequently disclosed ways and means by which the production could be considerably increased.

The system of inspection and payment has been simplified and made as businesslike as possible. More than 1400 inspectors are either in the direct service of the Depot or are at command, much of the inspection being handled by R. W. Hunt & Co. These inspectors not only pass the material, but accept it. They deliver to the contractor a certificate of inspection which the latter sends to the General Engineer Depot with his invoice, and payment is made immediately.

In this way firms which negotiate for materials and have big labor bills are able to meet their obligations with promptness, an important factor in securing satisfactory bids.

The original article gives a chart indicating the organization of the War Departments General Engineer Depot. It also contains a list of the principal officers in charge of the various sections. The majority of these officers had extensive previous experience, many of them in commercial employment. (*Engineering News-Record*, vol. 89, no. 1, January 3, 1918, pp. 25-29)

### Society of Automotive Engineers

The thirteenth meeting of the Society of Automotive Engineers was held on January 9 and 10. The first day was devoted to various committee meetings, and the second to society business, such as election of officers, etc., and professional sessions. Charles F. Kettering was elected president for the coming year.

At the professional sessions three main subjects were discussed: the Liberty airplane engine, the design of the U. S. war truck, and the question of fuel for automotive apparatus.

As regards the Liberty motor, the main paper was presented by Major J. G. Vincent, Mem.Am.Soc.M.E., one of the two men who, according to Secretary Baker's statement, were locked up in a room in the Willard Hotel and told to design the American aviation engine.

The first unit designed was an 8-cylinder engine of about 150 hp., but before that was completed it was decided to provide a 12-cylinder engine giving over 300 hp. At present only the 12-cylinder engines are being turned out and it is not believed that smaller engines will be built during the war.

In the discussion which followed, H. M. Crane called attention to the fact that an engine cannot be copied. As an instance, he cited the Mercedes engine. A number of attempts have been made to copy it, but none of these copies can be compared with the original in efficiency and usefulness.

The Liberty motor is an embodiment of the idea of a small number of parts, simplicity of parts, and compactness, all of which make for light weight and reliability.

There is no reason why the Liberty engine cannot be operated satisfactorily at low speed. It has no unusual valve timing. The exhaust valve opens 52 deg. early and the inlet closes 45 deg. late.

Fuel is fed by pressure, auxiliary tanks being provided for emergencies. The lubricating system is of the pressure type with the double-deck pump and three gears in the top deck.

Two compression ratios are used at present for the Liberty engines. In the navy engines, which have to fly at altitudes of about 5000 ft. or less, the compression ratio is 5 to 1; in the army engines for altitudes of around 10,000 ft. or higher, it is 5.4 to 1, or something under 18 per cent.

The steel cylinders are so arranged that the cooling water can be brought up close to the spark plugs. The compression pressures have not yet been carried extremely high in the Liberty engine, so that spark-plug trouble as ordinarily known in aviation engines has not been experienced.

The design of the Class B military truck engine was discussed in a paper presented by A. F. Milbraith, Mem.Am.Soc. M.E.

It was desired to develop an engine with a torque output of at least 2800 lb.-in. An average of the daily performance of engines built in the past is about 6¼ lb.-in. per cu. in. of piston displacement, which indicated a piston displacement for the engine of about 450 cu. in.

As it was desirable to keep the stroke-bore ratio as high as possible without excessive total weight or overall height, a 6-in. stroke was adopted with a bore of 4¾ in. The normal speed was set at about 1050 r.p.m., giving a piston speed of 1050 ft. per min. The speed of maximum horsepower was predetermined at about 1500 r.p.m.

The paper describes in detail the various features of design. Of particular interest are the inlet and exhaust manifolds. They are both on the right-hand side of engine. A heating chamber is cast integral with the inlet manifold near the center, where the vertical branch from the carburetor joins the horizontal section. This heating fixture is bolted directly to the exhaust manifold at a point where an opening is caused by the latter, so that the hot gases are circulated around the inlet manifold. This forms a hot spot about four of five inches long which helps vaporize the fuel and permits the use of low grades of gasoline.

From tests made it appears that a torque of 7.27 lb.-in. per cu. in. of piston displacement was obtained, while the maximum horsepower would be developed at 1550 r.p.m. (Abstracts of these two papers are made by special courtesy of the Society of Automotive Engineers from advance proofs. The full texts of the papers will appear in an early issue of the *Journal of the Society of Automotive Engineers.*)

## New York Automobile Show

The Automobile Show held at Grand Central Palace, January 5 to 12, was, in many respects, one of the most remarkable exhibitions of its kind.

The latter part of the period of preparation for the show passed under conditions of great stress, with the air full of apparently authentic rumors of drastic curtailment of the passenger-car industry.

Fortunately, by the time the show opened its doors to the public the great importance of the American automobiles to the country and the prosecution of the war became clear and the position of industry reasonably assured.

The show did not exhibit any clearly war features of the automobiles and the conditions created by the events of the last year could be observed only indirectly. It is but natural, however, that they should have begun to exert their influence on the design of the cars.

There are two elements, which, if one may judge by the last show, are going to affect the industry most profoundly. The first is the growing tendency toward economy both in the size of the car and the mileage per gallon of fuel. The day of the big, heavy car has not passed, of course, because there will probably always be those who can afford to use it, or conditions where its use may be particularly necessary. But it is significant that practically all of the new cars exhibited at the show are small cars, and that at least one car has already reduced the length of the wheelbase which it employs in its standard model.

Another feature is the tendency toward the better utilization of fuel in the engine. This is achieved in various ways. In the first place there is more extensive application of devices for a better gasification of the fuel, either by the use of jacketed carburetors or by the application of the so-called hot-spot method, that is, superheating a section of the intake manifold by a flow of exhaust gas. Since this latter method has been applied even in the Liberty truck, it may now be considered as current practice.

The other way of better utilization of fuel is by better temperature control of the jacket cooling water. This, as exhibited at the show, is effected in two ways; either by means of a thermostatically controlled valve in the jacket waterline, usually at the outlet to the radiator, or by shutters located in front of the radiator and operated either manually or by means of a thermostat and lever transmission.

Finally, one car has the thermosiphon circulation with a thermostat in the waterline and manually operated shutters in front of the radiator.

Many minor refinements of design have been exhibited, such as an enclosed valve head with the valves operating in a mist of oil; a radiator attachment to condense alcohol used as a preventive of freezing, etc.

## Student Units for the Army Authorized at Two Colleges

The War Department has issued the following orders:

By direction of the President and pursuant to the authority invested in him by the provisions of section 41 of the act of Congress approved June 3, 1916, and in response to the application of the Massachusetts Institute of Technology, Cambridge, Mass., the authorities of which have agreed to establish and maintain a two-years' compulsory course of military training as a minimum for its physically fit male students, which course, when entered upon by any student, shall, as regards such student, be a prerequisite for graduation, to allot a minimum of an average of three hours a week per academic year to military training and instruction during the first two academic years and to arrange for five hours per week during the remainder of such student's course, and to use their endeavors to promote and further the objects for which the training corps is organized, there is hereby established in said Massachusetts Institute of Technology, Cambridge, Mass., one Coast Artillery unit, one Signal Corps unit, of the senior division, Reserve Officers' Training Corps.

By direction of the President and pursuant to the authority vested in him by the provisions of section 41 of the act of Congress approved June 3, 1916, and in response to the application of the University of Colorado, Boulder, Colo., the authorities of which have agreed to establish and maintain a two years' compulsory course in military training as a mini-

mum for its physically fit male students, which course when entered upon by any student shall, as regards such student, be a prerequisite for graduation, to allot a minimum of an average of three hours per academic year to military training and instruction during the first two academic years and to arrange for five hours per week during the remainder of such student's course, and to use their endeavors to promote and further the objects for which the training corps is organized, there is hereby established in said University of Colorado, Boulder, Colo., an Infantry unit of the senior division, Reserve Officers' Training Corps. (*Official Bulletin*, January 10, 1918, p. 2)

## The Aeronautical Situation

"I have just returned from a visit to the aircraft works in Buffalo, Detroit and Dayton. This was an official visit and so I have seen everything there is to be seen in regard our aircraft program. I can hardly express my feeling of depression. The Liberty motor is coming along splendidly, and it is going to be a great success. But we are not going to have any mechanics competent to repair it. It takes longer to train a mechanic than a pilot. Major Vincent, the man who designed the motor, told me that it would be over a year before we could hope to have mechanics even in small numbers. So far we have made one airplane suitable for use in Europe. The manufacturer assured me that his company could not be on a production program until after the first of July.

"We are having a large number of school planes made, but there are no engines for these. The man who was entrusted with the work has fallen down completely. Even if we were to have the school planes ready we do not have one-tenth the requisite number of teachers, and cannot hope to get them for six months.

"It is very hard to place one's finger on the man or committee responsible for this condition. As far as I could see, the evil is a fundamental one." (From a letter by Professor Joseph S. Ames in the *Atlantic Monthly*, vol. 121, no. 1, January 1918, Contributor's Column)

## Rules for Enlistment in Aviation Section of Men of Draft Age

The Aviation Section of the Signal Corps authorizes the following statement to clear up any misunderstanding which may exist as to the enlistment of men in or under the draft age on account of the recent ruling discontinuing voluntary enlistment as a general practice:

Fliers and balloonists may enlist as heretofore upon passing the examination at the nearest aviation examining board. Their relationship to the draft and to the draft board is seen to by the examining board. They themselves are ordered into active service as soon as possible and hold the status of privates, first class, Signal Enlisted Reserve Corps, with a salary of $100 a month, 60 cents daily allowance for food, and quarters provided by the Government, until their commissions are issued or they are discharged.

Non-flying officers of draft age or below are not now being accepted for service, except a limited number of graduates of leading recognized engineering colleges or others who can qualify as expert engineers; others may, if they wish, have their names placed on file at an examining board.

Aerial observers are not now being accepted, whether of draft age or not.

Enlisted men within the draft age may now no longer volunteer at a recruiting office, but may be inducted voluntarily into service by their local board if they are physically fit, sufficiently skilled, and not required to fill the current draft quota. They will be sent to Camp Kelly, Tex., for distribution into trades, training and formation of squadrons, with ranks and salaries running from $30 a month as private to $81 a month as master signal electrician, food and quarters provided by the Government. (*Official Bulletin*, December 27, 1917, p. 16)

## Flotation of Ships

The possibilities of insuring the flotation of a large ship after severe damage were discussed before the Institute of Marine Engineers by Charles V. A. Eley, who in particular dealt with the system he himself has devised.

This system combines direct pumping with central means for indicating the position and amount of the damages for operating the pumps, and for leveling the water in the ship in order to preserve a level keel. Collision mats of a special character may also be used.

In connection with these arrangements some of the ship engineers would be trained to act as "salvage engineers," who would go to their stations when the vessel was in trouble or in a danger zone in the same way as a gunner would go to his station. The station would be a small compartment, say, 12 ft. to 15 ft. long and 6 ft. or 7 ft. wide, in the most invulnerable part of the ship. On one of the longer sides, about 6 ft. above the deck, a flat sentinel model of the ship would be placed with slides to operate vertically as indicators to show at a glance if water were building up in any compartment and at what rate. Below each compartment of the model would be placed the means for starting the pumps fitted in each compartment. On the deck, close to the side of the compartment containing the model, there would be a system of levers, almost like the levers in a railway signal box, one for each compartment of the ship, and these levers would control the opening and closing of the valves for leveling the water in the ship, preferably through the double bottom where such exists. Then supposing the ship is damaged at, say, the third compartment from the stern, the indication of the model will show that the water is rising in that compartment, and the salvage engineer will start the pumps on it.

If he sees these are not sufficient to deal with the water entering the ship he will pull over the lever at the same position (No. 3) and let the water travel throughout the length of the ship, and supposing there are twenty compartments, will pull over No. 18 lever and start the pumps in No. 18 compartment. If he finds the water to be still gaining he can pull over levers Nos. 9 and 17 and start the pumps in those compartments, and so on until the water is being pumped out faster than it enters. The ship's carpenter and crew could put into position specially constructed collision mats, or make good inside of the ship, or do both, as by keeping the vessel buoyant by pumping, the inside of the damaged compartment would be opened for purposes of inspection or to make good the damage temporarily.

As a rule, the auxiliary pumps on a ship are not sufficient to deal with the water inflowing through collision or torpedo, but would require to be supplemented with a complete set of pumps capable of being started together and of utilizing the whole, or as much as might be necessary, of the forces existing in the ship for purposes of propulsion to expel water. The author thought that the involute centrifugal single-stage pump

would be the best for the work, though in certain cases the expulsion form of steam pump or even steam-jet pumps might be considered; and in the remainder of his paper he set forth various calculations as to the installation that would be required in the case of a large vessel. (Philadelphia *Public Ledger,* December 26, 1917, p. 13.)

## Patent-Reform Prospects

The Patent Office Society is permitted to announce that a composite committee has been created upon request by the National Research Council to make a preliminary study among the problems of the United States Patent Office and its service to science and the useful arts. This action is understood to be in conformity with the wishes of Commissioner of Patents, J. T. Newton, and Secretary of the Interior, Franklin K. Lane.

According to the resolutions adopted by the Patent Office Society, this is the proper time for taking preliminary steps about the establishment of the institute, such as was proposed some time ago by George Sarton and others, for the history of science, a proposal which is supported also by the Washington Academy of Science.

The Patent Office corps feels that the time is at hand when the Patent Office must enter upon either a period of very rapid decline, or else upon a period of rehabilitation and expansion.

The special committee asks some very pertinent questions. For example, can all who are employed in the work of examination be in any way further encouraged and aided to become specialists in one or the other of the branches of applied science, rather than mere rule parrots and picture matchers? This, apparently, implies a desire on the part of the examiners to be placed in a position where they could investigate new applications on the basis of a full knowledge of the previous art, rather than, as is a fact to a certain extent now, be guided mostly by Patent Office indexes.

Another question is whether the rules against dilatory prosecution of applications made by Commissioner Ewing be rendered secure for the future, in order to create a diligent rather than dilatory prosecution.

Before Commissioner Ewing's time the rules were such that applications could be kept alive for many years. Thus, the famous Selden patent was kept alive for nearly twenty years, which was easy since the applicant had two years for each amendment, and, for example, Selden used to file his amendments, sometimes of a trivial nature, just a few days before the lapse of the two years. Commissioner Ewing changed all this, reduced the time for filing amendments, and gave the Patent Office means of enforcing a rapid prosecution of an application.

The Patent Office Society requests that sugestions on patent reform be forwarded at once to Dr. Wm. F. Durand, (Mem. Am.Soc.M.E.), National Research Council, Washington, D. C. It is not expected that patent reform can claim primary consideration during the continuance of the work, but it is felt that the time is ripe for, at least, a study of conditions. (*Science,* New Series, vol. 46, no. 1200, December 28, 1917, pp. 629-631)

## British Electrical Power Plan to Save Coal

The big electrical power-supply scheme, formulated by the coal-conservation sub-committees of the Ministry of Reconstruction, is the latest item to be made public of the Ministry's important proposals for the future. The scheme has been issued in an interesting report by the sub-committee to the Ministry so that public opinion may have an opportunity to form itself.

How much of the scheme will be adopted remains to be seen, but Dr. Addison, in a preface, draws attention to the important issues, affecting municipalities and public bodies, raised in the report and states that the Government will explore all the sub-committee's proposals before proposing any action to Parliament.

The scheme, it is expected, would save 55,000,000 tons out of the 80,000,000 tons used in the United Kingdom for producing power.

The cost of this 80,000,000 tons at the pit head is roughly £40,000,000, and of this £27,000,000 could be saved. With the saving of by-products now wasted by burning coal in open grates and boiler furnaces, a national economy of £100,000,000 could be effected. The coal now used would if used economically, it is said, produce at least three times the present amount of power.

Increased use of electric power, it is pointed out, is the most economical way of obtaining power from coal, is the best way to increase the net output per head, with the resulting prosperity of the workers.

The committee makes proposals for getting the fullest value of by-products and for generating electricity in subsidiary plants wherever there is surplus gas or waste heat as at furnaces and coke ovens. Similarly waste coal left at pits could be used on the spot.

The committee point out that the Northeast Coast district is already served by a group of power companies from one intereonnected electric system. Despite the smaller population and disadvantages for electrical supply as compared with Lancashire, which has a multiplicity of electrical undertakings, the price per unit in this district is from one-half to one-quarter the price per unit in Lancashire, while the use of electric power per head is three times as great.

The scheme in the Northeast Coast district has meant a saving of coal, reduction of smoke, greater traffic facilities through the adoption of electric traction than in any other district of similar size, the establishment of new industries in the district, and the practical elimination of the burning of coal for power, apart from the electrical power company's consumption, the railways and some collieries.

Among the advantages the committee foresees are the elimination of factory chimneys and the smoke nuisance, electrification of railways even for goods trains, electric light for the poorest classes, and so forth. The development of a technically sound system of electricity supply, the committee states, is essentially one with the problem of the industrial development of the country. (*Christian Science Monitor,* January 2, 1918, p. 1)

## May Admit Women to U. of P. in Month

To offset the loss of more than 2000 students who have enlisted in various branches of the Government service, all departments of the University of Pennsylvania will be declared open to women, beginning with the second term in February, according to an unofficial statement made yesterday by a university official.

One of the reasons and perhaps the chief one for hurrying the general admission of women is the $250,000 deficit the university faces on account of its reduced enrollment. During the Christmas holidays scores of students have gone into the

service and will not reopen their books. Many of these men would have graduated this year, but a large number are below the draft age and could have remained at school for a year or two. Prior to the holidays these students were advised that it was their duty to remain in college until they were called, but virtually all paid no heed to the admonitions. In one department alone—the Wharton School—fifty-seven students enlisted within ten days. (Philadelphia *Public Ledger*, January 3, 1918, p. 7)

## Oil Experimental Station at Bartlesville, Okla.

Secretary of the Interior Lane has designated Bartlesville, Okla., as the location of the new experimental station of the Bureau of Mines for the investigation of problems relating to petroleum and natural-gas industries. The station is one of the three new experimental stations for the establishment of which the sum of $75,000 was appropriated by the last Congress. The two other stations have been located at Minneapolis, Minn., for the study of iron and manganese problems, and at Columbus, Ohio, for research connected with ceramic and clayworking industries.

The technical staff of the new experimental station will study various problems having practical commercial application to the petroleum and natural-gas industries, including questions of productions, transportation, storage and refining of petroleum and various problems connected with the technology of natural gas.

One of the greatest needs of the petroleum industry has been the coördination of scientific research with the practical side of industry, for compared with other mineral industries it has been singularly backward in this respect. The station is aimed to act as an intermediary between the facts evolved by scientific investigations and the needs of the oil industries. That is, men will be employed who will be able to gather scientific data and find out how they may be applied to the practical needs of the industry. (*Official Bulletin*, January 9, 1918, p. 10)

# U. S. BUREAU OF STANDARDS

A NEW type of rope-measuring device or rope meter has been thoroughly investigated by the Bureau, using different sizes of ropes in the range of capacity of the instrument and different methods and tensions of pulling the rope through the meter. Suggestions for the improvement of the meter were made to the manufacturer in the Bureau's report.

*Space Occupied per Ton of Various Commodities.* In connection with the shipping of Government supplies to the front, the Bureau is now engaged in compiling data as to the cubic contents per ton of practically all such commodities. The purpose is to determine the most effective distribution of freight in relation to the available facilities. The sources from which such data are to be obtained have been ascertained and the work of collecting this information is in active progress.

*Measurement of Metal Hardness.* Data have been gathered by the Bureau as to the hardness numerals obtained with the "Brinell meter" and the "universal Brinell machine." The relative agreement of hardness numerals obtained from depth and diameter measurements is also being determined. The object is to ascertain the relative precision of these instruments, standardize the practice, and facilitate the general tests for hardness. The work is nearly completed.

*Radium Luminous Materials.* The use of self-luminous materials for the figures on the dials of measuring instruments for night use has called for the careful measurement of the relative brightness of such materials. Methods of measurements have been developed at the Bureau and a standard procedure has been formulated for routine work. The Bureau is investigating possible methods of avoiding the large loss of brightness involved in the present methods of applying luminous materials, with excellent prospect that the loss can be greatly reduced.

*Standards of Gas Service.* Two important problems have arisen in connection with standards for gas service. Some companies cannot maintain quality at the prevailing price without a loss. The second problem is the making of arrangements to secure the supply of toluol needed for military purposes and which can be most readily obtained from illuminating gas. The two problems have become confused and the Bureau of Standards is endeavoring to consider each separately on its merits. The War Department has been given assistance on the technical aspects of the latter subject, and an article on toluol recovery and standards of gas quality has been sent to the trade journals to secure the needed publicity. As illustrating the changed economic conditions in the gas industry, the Bureau has prepared a statement of the technical phases of the gas situation in the District of Columbia for the use and guidance of the Public Utilities Commission of the District.

*Metals.* New data have been obtained on light alloys and four reports have been issued by the Bureau on the several phases of its work in this field. New automatic recording apparatus has been designed for taking cooling curves and improved methods of manipulation were devised and tested out in practice. The new apparatus gives more satisfactory results, particularly at the lower temperature ranges, and the characteristics of the curves are more sharply defined.

*International Aircraft Standards.* The Bureau continues to take an active part in formulating the new International Aircraft Standards. During the past month 14 of these specifications were completed and published.

*High-Purity Platinum.* In the Bureau's investigation of platinum purity recent tests have developed the interesting fact that the highest possible purity attained hitherto only by a German firm can now be equaled by an American refiner of platinum. This will be of much interest to those concerned with the technical use of highly pure platinum, the supply of which was cut off very shortly after the beginning of the war.

*Fire Resistance.* Progress is being made in the Bureau's investigation of the fire-resisting properties of reinforced-concrete columns. A new column was made up to test out the simple expedient of holding the protective covering in place under fire conditions. The tiewires connecting the vertical rods with the hooping were cut and free ends allowed to project outside of the reinforcement. These are intended to service as anchorages or ties to prevent slabs of the protective covering from falling away from the column exposing the load-bearing portion to the heat as soon as the covering breaks by reason of the expansion.

*Safety for the Household.* The safety of the home is the subject of a new pamphlet just issued by the National Bureau of Standards. An interesting account of household hazards is given. The topics are discussed clearly in a manner which

would afford a basis for popular education in "Safety First." The dangers from electricity, gas, fire, lightning, household chemicals, and the other common causes of accident are recited, and many actual cases are described. The purpose is to aid in removing needless risk and fear, and to develop intelligent caution where the hazard cannot be entirely avoided.

The hazards of the home have increased in modern times from the service of gas and electricity and the use of such dangerous articles as matches, volatile oils, poisons, and the like. The use of energy in the home necessarily involves some risk, which intelligent planning and care will reduce to a minimum.

Caution alone is not enough, since many of the dangers are not even suspected. The nature of such unknown hazards must be made plain. The circular emphasizes the seriousness of some of the risks not generally known, gives simple cautions, and aims to guide the formation of habits of carefulness. The circular also suggests effective home equipment to minimize the risks involved, and aims to encourage public measures to provide safety for the household and community.

It is intended, not to increase fear of accident, but rather to remove the causes and the need for alarm. The sense of safety to be gained by observing these cautions would alone justify the careful study of this new circular. This circular completes the series of three popular household circulars which deal with measurements, materials, and safety. These form a valuable addition by the Bureau of Standards to the literature on household management.

The appalling loss of life from avoidable causes and injury to person and property make the pamphlet especially timely. It is believed that thousands of human lives could be saved and accidents reduced to a minimum if the precautions suggested are followed.

*Leather Research.* Results have been compiled covering laboratory tests and actual service tests of a special tannage of sole leather. Investigation has been conducted to study the wearing qualities of sole leather and of composition soles. The experiments comprise accelerated wearing tests on a machine provided for that purpose and actual service tests conducted by postmen and other Government employees. Similar service tests will be made on shoes worn by soldiers. A study of the water absorption of different grades of sole leather is in progress.

## This Month's Abstracts

The simplest—apparently—phenomena of nature may yield results of great importance, if thoroughly and skillfully analyzed. The boiling of water in a metal cup over a gas flame is an everyday experience in practically every household, and what happens there has been supposed to be well known. As a matter of fact, however, Dr. Carl Hering's investigation reported in the section Steam Engineering shows that by changing the shape of the bottom of the cup in an appropriate way, an evaporation many times greater than that obtained from the flat-bottomed cup may be secured.

In the section Coolers is described the Heenan method for cooling the jacket water from stationary gas engines in use in India. It is of the open-film type of apparently simple construction.

In the section Engineering Materials are reported several investigations on binary alloys and also two investigations on properties of steel at high temperatures. In the investigation on the thermal expansion Kotaro Honda has determined the relation between the coefficient of expansion of various steels and the contents of impurities, also the elongation curves in the various stages of transformation. The data obtained from this investigation give an insight into the causes of cracking of steel in cooling.

An investigation on the effect of the presence of a small amount of copper in medium-carbon steel by Carle R. Hayward and Arch. B. Johnston has shown that steel containing 0.860 per cent copper is, in practically every respect, superior to steel containing 0.30 per cent copper.

In this connection the article by F. H. Mason in *The Mining and Scientific Press* becomes of considerable interest, in that it discusses the direct production of steel from Sudbury ores. There one of the difficulties lay in the presence of about 1¼ per cent copper, which it was believed would make the steel hot-short. F. H. Mason shows, however, that the presence of nearly 3½ per cent of nickel neutralizes this deleterious effect of copper.

In the section Engineering Materials is found an article on the production of pig iron from scrap steel, the so-called synthetic pig iron. It is one of the outgrowths of the abnormal war conditions in the raw material market, but an important one at the present moment.

A double-pass recuperative furnace is described in the section Furnaces.

A mathematical investigation of the flow of water in siphons is abstracted in the section Hydraulics from a paper presented before the Institution of Mining Engineers (Great Britain).

In the section Internal-Combustion Engineering, Cole Newman describes a modified-cycle Diesel engine with compound expansion, which he believes might be suitable for use on motor vehicles. In the same section will be found a discussion of the question of uniformity of multi-cylinder engines in its bearing on engines having no flywheels. The Howard cuff-valve engine is described in the same section.

In the section Lubrication will be found a description of the Michell automatic lubricating gear, the purpose of which is to lubricate during starting and stopping.

The calibration of anemometers is discussed by A. H. Anderson, Mem.Am.Soc.M.E., who claims that the short-arm method of calibrating anemometers may give quite erroneous results.

Formulæ to be used in pin measurement of spur gears are given by Reginald Trautschold in an article abstracted from *Machinery*.

In the section Mechanics, Wilhelm A. Schmidt, Mem.Am.Soc.M.E., discusses further the relation of press stroke to the life of a die, and shows that the whole question in the final count comes down to the number of strokes at the same cutting velocity of the punch within a given time. It is natural that if the same cutting velocity can be obtained with the shorter stroke that was formerly obtained with the longer stroke, the number of useful strokes per unit of time would be greater in the first case.

Tests made by the Research Department of the National Tube Company have shown that in pipe joints the round thread is superior to the Briggs thread in various regards.

In the section Munitions will be found a bibliography on the French 75-mm. cannon, the famous "soixante-quinze," prepared by the Library of the United Engineering Society.

In the section Steam Engineering is reproduced a brief mathematical investigation by Gerald Stoney on the divergence of steam nozzles, originally appearing in *Engineering*.

Heat transfer in tubes by W. Nusselt is indirectly abstracted from the *Journal of the Society of German Engineers*, while from the *Proceedings of the Royal Society* is abstracted an interesting investigation on the specific heat of water by W. R. Bousfield.

# REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS


GASOLINE-DRIVEN AIR COMPRESSOR
HEENAN MECHANICAL WATER COOLER
THERMAL EXPANSION OF STEEL AT HIGH TEMPERATURES
MEDIUM-CARBON STEEL WITH SMALL AMOUNT OF COPPER
PIG IRON FROM SCRAP STEEL
SYNTHETIC PIG IRON
METALLOGRAPHIC INVESTIGATIONS OF BINARY ALLOYS
NICKEL-COPPER STEEL DIRECT FROM SUDBURY ORES
NEUTRALIZATION OF COPPER IN STEEL BY NICKEL
THERMAL AND ELECTRICAL CONDUCTIVITIES OF CARBON-STEEL AT HIGH TEMPERATURES
PEANUT OIL AS DIESEL-ENGINE FUEL
DOUBLE-PASS RECUPERATIVE FURNACES
AUTOMATIC HYDROELECTRIC PLANT
FLOW OF WATER IN SIPHONS
LIGHT DIESEL ENGINE FOR MOTOR VEHICLES
UNIFORMITY OF MULTI-CYLINDER INTERNAL-COMBUSTION MOTORS
HOWARD CUFF-VALVE ENGINE
MICHELL AUTOMATIC LUBRICATING GEAR
HEAT TREATMENT OF SHELLS
BORING AND REAMING TOOLS FOR LARGE FRENCH SHELLS
DIAMOND TOOLS IN THE SHOP
MOTOR-DRIVEN PLANERS
CALIBRATION OF ANEMOMETERS
PIN MEASUREMENT OF SPUR GEARS
PRESS STROKE AND LIFE OF DIE
TORSIONAL RESISTANCE OF ROLLED JOISTS
TYPE OF THREAD AND PIPE JOINT
STEAM MOTORCYCLE
STEAM TRUCK ENGINE
FRENCH 75 MM. CANNON
BRITISH 4-CYLINDER EXPRESS LOCOMOTIVE
DIVERGENCE OF STEAM NOZZLES
FILM RESISTANCE IN FLAME-HEATED VESSELS
PLUGS AS MEANS OF INCREASING BOILER EVAPORATION
HEAT TRANSFER IN TUBES
SPECIFIC HEAT OF WATER


*For Articles on Subjects Relating to the War, see Aeronautics, Engineering Materials, Machine Shop, Munitions, Varia.*

## Aeronautics

SPECIAL SPARK PLUGS NEEDED FOR AIRPLANE ENGINES. *Automotive Industries*, vol. 38, no. 1, Jan. 3, 1918, pp. 29-32, 4 figs. 1. Unusual Insulating Materials Seldom Withstand Heat; 2. Electrode Must Be Specially Cooled; 3. Oil Must Not Reach Insulation or Must Be Burned; 4. Plug Must Have Good Mechanical Strength.

OVERHAULING THE GNOME AIRPLANE ENGINE. *American Machinist*, vol. 48, no. 1, January 3, 1918, pp. 9-15, 16 figs.

BRITISH AVIATION ENGINE INSPECTION, Lieut.-Col. R. K. Bagnall-Wild. *Automotive Industries*, vol. 38, no. 2, January 10, 1918, pp. 125-130, 2 figs., 3 charts. Part 1: Chart scheme of couple system in use; best methods of employing women in work; routine for rejection by government men; plan of using approved firms is favored; advantages of inspection to companies. Pt. 2 to follow.

SOME NOTES ON RECENT GERMAN AEROPLANES. *The Engineer*, vol. 124, no. 3233, December 14, 1917, pp. 516-518, 6 figs.

THE ARMAMENT OF AEROPLANES. *Engineering*, vol. 104, no. 2708, November 23, 1917, pp. 544-546, 24 figs.

AEROPLANI VELOCISSIMI. *Revista Marittima*, Anno 50, no. 9, September 1917, pp. 355-366, 2 figs., 4 charts, 2 tables. Gives formulæ and curves showing the relation of aeroplane displacement to speed, radius of action to speed, engine power to speed; also a table for various types of machines giving weight of machine, weight of power plant, output, and radius of action. An abstract of this article will be given in an early issue.

ON THE MAXIMUM FLIGHT VALUE OF AEROPLANES, Umberto Nobile. *Aeronautics*, vol. 13, no. 216 (New Series), December 5, 1917, pp. 434-436, 2 charts.

## Air Engineering

THE TEMPERATURE OF EVAPORATION, ITS PRACTICAL APPLICATION TO AIR CONDITIONING AND TO THE DRYING AND CONDITIONING OF MATERIALS, W. H. Carrier. *Journal of the American Society of Heating and Ventilating Engineers*, vol. 24, no. 2, January 1918, pp. 227-248, 6 figs.

DUST: ITS UNIVERSALITY, ELIMINATION AND CONSERVATION, E. R. Knowles. *Journal of the American Society of Heating and Ventilating Engineers*, vol. 24, no. 2, January 1918, pp. 285-327, 44 figs.

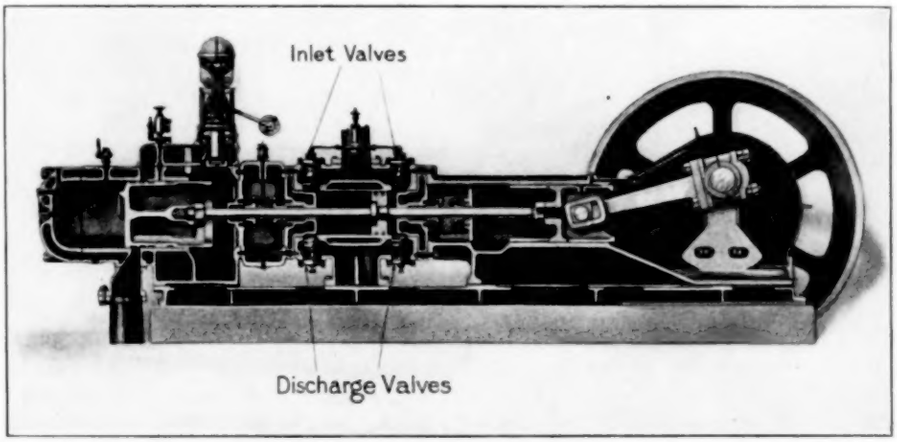



FIG. 1 GASOLINE-DRIVEN AIR COMPRESSOR

## Air Machinery

GASOLINE-DRIVEN AIR COMPRESSOR. Fig. 1 shows a section through a gasoline-driven air compressor, built by the Chicago Pneumatic Tool Company. It is of the horizontal, straight-line, single-stage, double-flywheel, enclosed-frame type. The power and air cylinders are connected in tandem.

The power cylinder is operated on the two-stroke cycle with low compression and high-tension electric ignition, a pressure governor regulating the amount of gasoline that is admitted to the cylinder.

The crosshead is of the single-piece box pattern without adjustable shoes, and it overtravels the guide nearly one-half its length at each end of its stroke; thus bringing the longitudinal wear on the guide on an even straight line throughout its length.

A combined speed and pressure governor is used in conjunction with the differential unloader on the gas-driven compressor. Together these automatically limit the speed of the machine, maintain a practically constant air pressure at all times, and reduce the load to a minimum when there is no demand for air. The unloader controls the air supply by permitting the opening to the air inlet valves and allowing the air in the cylinder to return to the atmosphere whenever the pressure in the receiver exceeds the predetermined amount. (*Power*, vol. 46, no. 25, December 18, 1917, p. 83, 1 fig., *d*)

## Coolers

MECHANICAL WATER COOLING ON THE HEENAN PRINCIPLE. The Heenan cooler was primarily designed for use with stationary internal-combustion engines, but may be used for other purposes. It consists of cylinders built up of galvanized sheeting wound into the form of a spiral with air spaces between each convolution. The sheeting forms a large cooling surface within a small space. The cylinders are caused to revolve slowly in a covered trough containing the water to be cooled, and in revolving they take up the thin film of water which wets both sides of the sheet. A fan fixed at the end of the upper part of the cooler casing causes air to be blown through the annular spaces of the cylinder. This cools the film of water on the sheets; a considerable additional cooling effect is obtained by the partial evaporation of the water film.

The construction of the cooler is shown in Fig. 2. It is stated that such a cooler for a 100-b.hp. engine working in a tropical temperature requires a floor space of about 6.5 ft. by 3.25 ft. with 3.5 ft. headroom, while the natural-draft cooling tower for the same capacity would be about 7 ft. square and 15 ft. high. The power required to operate the cooler is said to amount to less than 1 per cent of the engine power for large sizes.

It is said that there are a large number of these coolers installed in India. One cooler to handle 30,000 cu. ft. of air per min. is working at the Calcutta Electric Supply Company's new power station at Cossipore in connection with the large turbo-alternator. (*Indian and Eastern Engineering*, New Series, vol. 41, no. 3, September 1917, pp. 85-86, 2 figs., *d*)

## Engineering Materials

THE THERMAL EXPANSION OF DIFFERENT KINDS OF STEEL AT HIGH TEMPERATURES, Kotaro Honda. Data of an investigation on the expansion of a Swedish iron, ordinary steel, and high-speed tool steel at various high temperatures.

To measure the expansion Chevenard's method was used and the measurements were made in a vacuum to avoid the oxidation of the specimens.

In particular, the relation has been determined between the coefficient of expansion of various steels and their content of impurities, especially manganese. In the case of Swedish steel the $A_1$ transformation is not observable in the elongation curve at all. In the range of $A_2$ transformation abnormal contraction is scarcely observable, but in the range of $A_3$ transformation a gradual contraction by heating and a gradual elongation by cooling are noticed. But in steel with 0.14 per cent carbon the abnormal change of length begins to appear in the $A_1$ transformation, clearly distinguishable from that during the $A_2$ transformation. This abnormal change of length in the $A_1$ range is more conspicuous in the 0.18 per cent carbon steel, while in the steels of 0.31 per cent and 0.44 per cent carbon, the temperature of the $A_2$ transformation noticeably decreases and the abnormal changes of length corresponding to the two transformations, $A_1$ and $A_2$, partially overlap each other.

It is also interesting to observe that manganese, even when present in a very small quantity in steels, affects their coefficients of expansion to quite a large extent.

The various high-speed steels show elongation curves rather similar to each other. They also show the abnormal contraction in the vicinity of 850 deg., probably due to the $A_2$ transformation. Their coefficient of expansion increases with temperature.

The following remark is made by the writer:

Since for high-speed carbon steels the abnormal elongation or contraction due to the $A_1$ and $A_2$ transformations takes

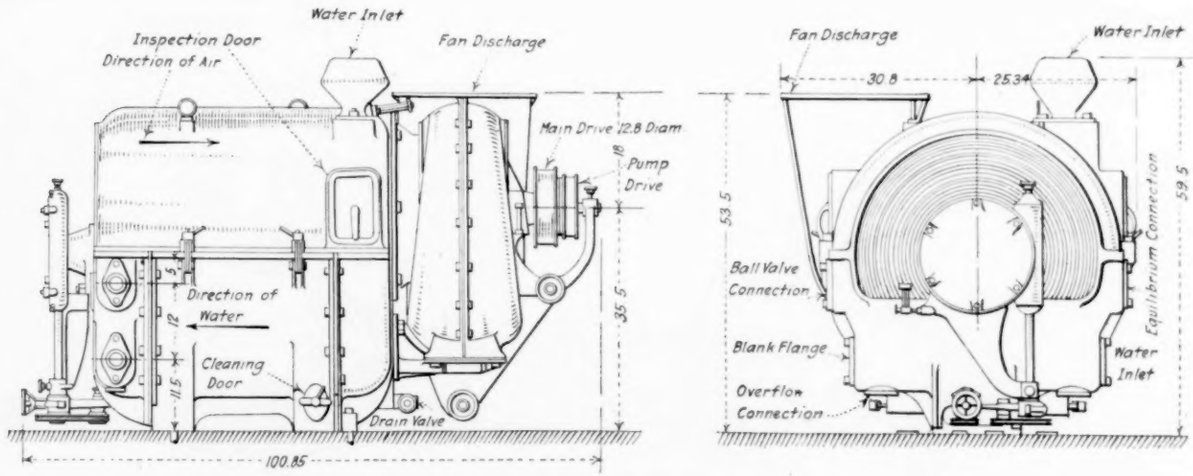



FIG. 2 HEENAN WATER COOLER FOR 200-B.HP. ENGINE WORKING UNDER TROPICAL CONDITIONS

place abruptly, it is possible that in the case when the temperature of a large specimen in the range of 700 deg. cent. is not uniform throughout the specimen, an internal strain and therefore an enormous stress will be developed during heating and cooling. During heating the inner portion is cooler than the outer portion, so that at about 700 deg. the outer portion contracts while the inner portion has not yet begun to contract, and therefore the outer portion exerts an enormous compression inward. During cooling the contrary is the case.

Besides the fact that the coefficients of expansion of steels investigated in the range of temperatures below the $A_1$ point increase rapidly with the temperature, it has also been found that the coefficient of expansion-temperature curves are slightly concave toward the axis of temperature, with the exception of some tungsten steels, for which the contrary is the case. (*The Science Reports of the Tohoku Imperial University,* Sandai, Japan, First Series, vol. 6, no. 4, pp. 203-212 and 6 pages of plates, *e*)

THE EFFECT OF THE PRESENCE OF A SMALL AMOUNT OF COPPER IN MEDIUM-CARBON STEEL, Carle R. Hayward and Arch. B. Johnston. Data of an investigation undertaken in order to obtain additional data on the mechanical properties of medium-carbon steel containing small quantities of copper. The discussion is introduced by brief references to previous investigations, which, by the way, agree that copper increases the tensile strength, but disagree in regard to the ductility, and touch only in a slight degree upon the question of resistance to shock.

In the present investigation two types of steel were tested: one containing 0.30 per cent copper, 0.012 per cent phosphorus, and 0.860 per cent copper, and the other 0.365 per cent carbon, 0.053 per cent phosphorus and 0.030 per cent copper. As regards the difference in phosphorus, the writers expressed the belief that it is probable that the effect of phosphorus is neutralized by this slight difference in carbon.

The bars tested have been subjected to various kinds of heat treatment. The samples were submitted to tensile tests, shock tests, Brinell and scleroscopic hardness tests, and a microscopic examination. The results are presented in the form of tables and curves, and of the latter Fig. 3 is here reproduced.

These tests have shown that in regard to tensile strength high-copper steel has a decided superiority. The yield point and ultimate strength are in every case higher, while the ductility is practically the same. The hardness tests by both methods show a high-copper steel to be harder than the low-copper, while the Charpy shock tests show a high-copper steel also superior to the low-copper. In all, the tests have confirmed the previous statement made by Stead that the behavior of copper steel resembles that of nickel steel. Microscopic investigation revealed that for the same heat treatment the high-copper steel was finer grained than the low-copper. The quenched and drawn specimens of high-copper steel were also found to be slightly more martensitic. (*Bulletin of the American Institute of Mining Engineers,* no. 133, January 1918, pp. 159-167, 1 fig., *e*)

PIG IRON FROM SCRAP STEEL. This is what is known as synthetic pig iron, and is a material that has now become a commercial product.

The production of munitions on an unprecedented scale has created a vast amount of scrap steel in the shape of shavings, ends, and rejected material. This, together with the general shortage of raw materials, has made it necessary to find a convenient method of utilization.

At first glance it may appear that converting steel into pig iron is a rather illogical method of procedure. Actually, however, especially in Europe, it has been found to answer the particular purpose of producing a uniform material from a mass of scrap of varying carbon content.

The new process is now being applied commercially in the United States at the Sweetzer-Bainbridge Metal Alloy Corporation at Watervliet, New York, where two 5-ton Ludlum electric furnaces are used with the daily output of about 50 tons per day.

The process is not really new but is quite simple, although the precise procedure is not published. The process is now basic. Ordinary scrap steel of any grade is introduced into the furnace cold, is melted and, if necessary, refined. After the desired refinement is reached the slag is removed. The necessary amounts of ferrosilicon and ferromanganese are

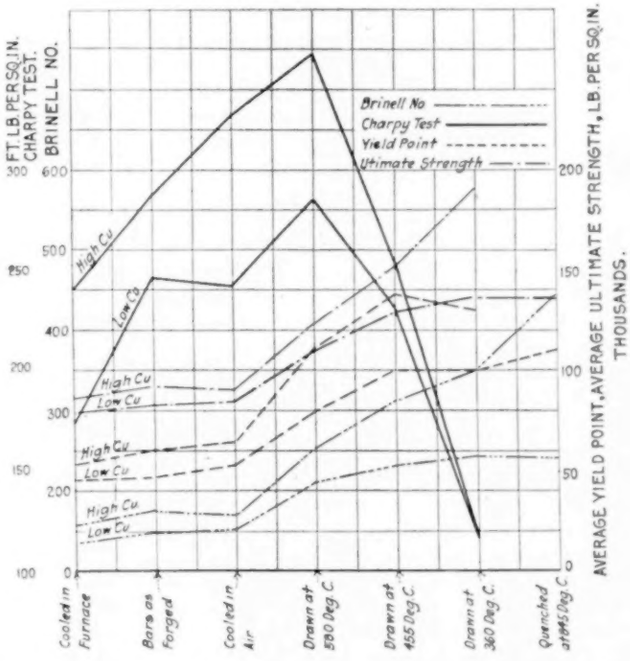

FT. LB. PER SQ. IN. CHARPY TEST. BRINELL NO.
AVERAGE YIELD POINT, AVERAGE ULTIMATE STRENGTH, LB. PER SQ. IN. THOUSANDS.
Brinell No
Charpy Test
Yield Point
Ultimate Strength
High Cu
Low Cu
Cooled in Furnace
Bars as Forged
Cooled in Air
Drawn at 530 Deg C.
Drawn at 455 Deg C.
Drawn at 360 Deg C.
Quenched at 845 Deg C.

FIG. 3 PHYSICAL PROPERTIES OF COPPER-BEARING MEDIUM-CARBON STEEL

added to bring the iron to the composition desired, and then the carbon is added in the form of fine coke, which is easily absorbed by the hot metal.

The regulation of the temperature and composition is quite simple, and a range from high-grade low-phosphorus iron and wash metal down to the high-phosphorus foundry and other irons is possible. The graphitic carbon content is regulated by the introduction of varying percentages of silicon. A knowledge of the composition of the scrap charged into the furnace permits to regulate quite closely the phosphorus and sulphur contents.

The pig iron is reported to be very tough and strong. As to cast iron in the form of castings, the experience of the Ludlum Steel Co. is cited. Cast-iron wobblers, for use in the company's rolling mill, which were purchased in the open market, were breaking at the rate of 10 to 12 per day. Wobblers from iron made in the electric furnace have been in use for two or three months without a case of breakage. The

company also made breaking boxes on the mill of electric cast iron. These should break easily when performing their normal function, but when made of this iron they were found to be entirely too tough, and their section had to be reduced considerably. It is believed that some explanation for these qualities may be found in the crystalline structure of the iron, as well as in its greater purity compared with cupola iron, because in the electric process, contrary to cupola practice, the sulphur decreases with each remelting. In making steel castings, the conversion loss is put at 5 per cent. The cost of production is one of the vital points. So long as low-phosphorus pig iron is selling at its present war price there can be no question as to the liberal profits obtainable. Whether in normal times such a method of making this grade or any other grade of pig iron or castings is economically possible depends on several factors. First among these are the consumption of electricity and the grade of scrap used. (*Mining and Scientific Press*, vol. 115, no. 23, December 29, 1917, pp. 936-938, 2 figs., *dp*)

METALLOGRAPHISCHE UNTERSUCHUNG ÜBER DAS SYSTEM VON TELLUR UND ALUMINUM, Masumi Chikashige und Jitsuzo Nosé;

METALLOGRAPHISCHE UNTERSUCHUNG ÜBER DAS SYSTEM VON SELEN UND ANTIMON, Masumi Chikashige und Masasuke Fujita;

METALLOGRAPHISCHE UNTERSUCHUNG ÜBER DAS SYSTEM VON ZINK UND SELEN, Masumi Chikashige und Rokuro Kurosawa;

METALLOGRAPHISCHE UNTERSUCHUNG ÜBER DAS SYSTEM VON CADMIUM UND SELEN, Masumi Chikashige und Riichi Hikosaka;

METALLOGRAPHISCHE UNTERSUCHUNG ÜBER DAS SYSTEM VON ALUMINUM UND SELEN, Masumi Chikashige and Tsugiji Aoki. Memoirs of the College of Science, Kyoto Imperial University, vol. 2, no. 4, July 1917, pp. 227-254, 19 figs. A series of metallographic investigations on the binary alloys aluminum-selenium, zinc-selenium, cadmium-selenium, antimony-selenium and aluminum-tellurium.

NICKEL-COPPER STEEL DIRECT FROM SUDBURY ORES, F. H. Mason. *Mining and Scientific Press*, vol. 116, no. 2, January 12, 1918, pp. 57-58. Discusses methods used. The process was formerly considered impossible as the material produced would contain more than 0.75 per cent copper and therefore might be expected to be hot-short. It has been found, however, that a slightly larger per cent of copper is harmless in the presence of a sufficiently large amount of nickel in the same steel.

TUNGSTEN AND HIGH-SPEED STEEL. *Engineering*, vol. 104, no. 2709, November 30, 1917, pp. 567-568. Description of processes used in the production of tungsten and especially high-speed tool steel.

RESEARCH ON REFRACTORY MATERIALS, G. E. Foxwell. *The Iron and Coal Trades Review*, vol. 95, no. 2595, November 23, 1917, p. 578.

L'INDUSTRIE ET LES GRANDES APPLICATIONS DE L'ALUMINUM PUR ET A L'ÉTAT D'ALLIAGES, Jean Escard. *Le Génie Civil*, Tome 71, no. 1843, December 8, 1917, pp. 375-378, figs. 11-14. Part 2. Discussion of the production of aluminum and aluminum alloys, chiefly with reference to France.

ON THE THERMAL AND ELECTRICAL CONDUCTIVITIES OF CARBON STEELS AT HIGH TEMPERATURES, Kotaro Honda and Takeo Simidu. The *Science Reports* of the Tohoku Imperial University, First Series, vol. 6, no. 4, November 1917, pp. 219-233, 4 plates. Data of tests carried out to determine the thermal conductivity of carbon steels at high temperatures as well as the electric resistances. As regards thermal conductivities it was found in Swedish iron-steel and iron that conductivity decreases at first slowly and then somewhat rapidly as the temperature is increased. Above the $A_2$ point it slightly increases in a linear relation to the temperature, a change of conductivity by temperature being apparently quite parallel with that of magnetization. Tests were carried out for temperatures up to 900 deg. cent. and it was found that for pure iron and nickel, and probably for all pure metals, Lorenz's law is exactly satisfied. Hence, for these metals the value of thermal conductivity at high temperature may be estimated from that of ordinary temperatures provided only the electrical resistance at the high temperature is known.

## Foundry

IRON OXIDE—ITS EFFECT ON MOLDING SAND, W. R. Dean. *The Foundry*, vol. 46, no. 305, January 1918, pp. 5 and 34.

THE OVERWEIGHT CASTING—ITS CAUSE AND REMEDY, R. R. Clarke. *The Foundry*, vol. 46, no. 305, January 1918, pp. 12-16, 1 fig.

THE MANUFACTURE OF PATTERN CASTINGS, Henry M. Lane. *The Iron Age*, vol. 101, no. 1, January 3, 1918, pp. 36-38, 7 figs.

## Fuels

PEANUT OIL AS FUEL FOR MOTORSHIPS. The large motorship *France* has successfully used peanut oil as fuel under ordinary ocean-going conditions, which confirms the former claim that Diesel-motor-driven vessels no longer need be dependent upon the supply of mineral oils.

Hitherto vegetable oils have been too expensive and insufficiently distributed to be considered as fuel for merchant ships, but the successful use of peanut oil may bring about a change in this view.

Southern Europe can obtain her supply of peanuts from northwestern Africa. In America there is also a large supply of peanuts. In fact, the Interstate Cotton Seed Crushery Association down South expects a peanut crop this season of a hundred million bushels. However, with the present price of American peanut oil at about 18 cents per lb., or $57 per bbl., it cannot be economically used for Diesel engines in this country. (*Motorship*, vol. 3, no. 1, January 1918, p. 6)

ALCOHOL AS A SOURCE OF POWER, W. T. Rowe. *The Engineer*, vol. 124, no. 3231, November 30, 1917, pp. 471-472.

FUEL SAVING SUGGESTIONS, Charles H. Bromley. *Power*, vol. 46, no. 24, December 11, 1917, pp. 786-789, 1 fig., 2 tables. The writer discusses some of the sources of appreciable loss of fuel when used under steam boilers and means for the elimination of such waste. He describes a recommended style of boiler setting for soft coal and gives complete specifications for this improved type of horizontal tubular boiler. A number of practical suggestions are included. Scraper conveyors, it is stated, are limited to about 300 ft. length. The relative advantages of bucket and bale conveyors are considered.

BLUE WATER GAS USED FOR METAL MELTING IN GREAT BRITAIN. *American Gas Engineering Journal*, vol. 107, no. 26 (whole no. 3121), December 29, 1917, pp. 588-593.

DOUBLE-PASS RECUPERATIVE FURNACES. Description of a type of furnace successfully used in Europe.

Notwithstanding certain known advantages in the operation of recuperative furnaces, they have not yet displaced the regenerative furnace, which is mainly due to the inability of the recuperative to withstand temperatures between 1300 and 1500 deg. fahr. for any length of time without undergoing repairs. This applies mainly, however, to the recuperative furnaces of the usual type. In Europe several recuperative furnaces are in successful operation and are of a construction different from those usually employed in this country. They are constructed of hollow-brick blocks, which are built with a male flange on one end and a female flange on the other, with walls 1⅛ in. thick. When several rows of blocks are placed adjacent they form flues through which the products of combustion pass. Other courses are mounted on top of and parallel to the first row of blocks. Traverse flues are formed between the upper and lower surfaces of these blocks, and it is through these flues that the secondary air is heated before mixing with gas.

The heating furnace is placed on top of the recuperator. The gas enters the lower combustion chamber of the recuperator and flows to the rear, where it mixes with preheated secondary air. This secondary air is heated by passing through ducts which are formed by the collars on the channel blocks when placed one upon the other. The temperature of the air is further increased by passing through another series of ducts, which discharge into a central chamber from which the air is directed to the combustion chamber. (*Iron Trade Review*, vol. 41, no. 24, December 13, 1917, pp. 1277-1278, 2 figs., *d*)

## Hoisting and Conveying

OPERATION AND MAINTENANCE OF ELEVATORS—WINDING-DRUM MACHINES, R. H. Whitehead. *Power*, vol. 47, no. 2, January 8, 1918, pp. 40-43, 5 figs.

SELECTION OF COAL AND ASH CONVEYORS, H. E. Birch. *Power*, vol. 47, no. 3, January 15, 1918, pp. 82-86, 10 figs. The writer believes that four items control the selection of coal- and ash-handling equipment: cost of operation, maintenance, interest on the investment, and adaptability. From his point of view roller flight conveyors are considered desirable.

## Hydraulics

AUTOMATIC HYDROELECTRIC PLANT. Description of a hydroelectric plant which is automatic in all its operations. The plant is so arranged that a rise of water level causes the proper number of generators to start to utilize water most economically. It belongs to the Iowa Railway & Light Co., and is located on the Cedar River.

This plant, which will have an ultimate capacity of 2000 kw., operates in parallel with an extensive transmission system. In the hydroelectric plant itself there are no instruments, all being installed in the company's steam station, which is about 0.6 mile distant. The connections are such that, while the hydroelectric station is self-controlled and automatic, it is possible for the steam-plant operators to control the action of the water wheels and generators.

One of the most spectacular features is the speed with which the station goes into service. It requires just 37 sec. from the time the first switch operates until the first generator is under full load. The system of electric controls is a double one: namely, either by float switches and contact-making ammeters in the hydroelectric plant, or by remote-control switches on the benchboard at the steam power plant.

As regards the hydraulic equipment, it is stated that the normal head at the plant is 10 ft., but the head may vary from 8 to 11 ft.

The dam is composed of nine 60-ft. spillway sections, each of which automatically rises and falls with the flowage of the river, giving an automatic flashboard effect. Four motor-driven Tainter gates are installed at the intake to the flue. Wheel pits at the power house are independent of each other, and are equipped with 20-ft. Tainter gates on the upstream side and stop logs on the downstream side. The water wheels are of the Francis single-runner type, measuring 171 in. in diameter, and are rated at 540 b.hp., 60 r.p.m. and 84 per cent efficiency under a 10-ft. head.

Fig. 4 indicates the method of using the Tainter gate and the position of busses with respect to the control cabinets.

The original article describes in detail the electric controls. An interesting feature of these controls is the safety provisions, especially important because the station is left attendantless, except for one visit every eight hours by an employee from the steam plant, and therefore must take care of its own cases of trouble if any arise. To that end the machines are protected against hot bearings by thermostats of the spiral-spring type installed on each bearing. These thermostats are set to operate at 45 deg. cent. In common with all other

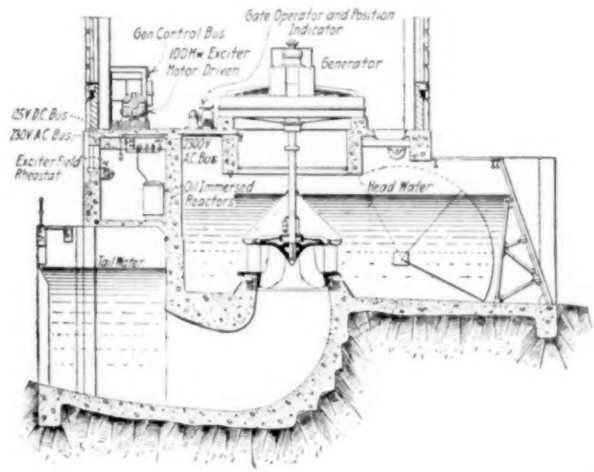



FIG. 4 CONTROL FEATURES OF CEDAR RIVER AUTOMATIC HYDROELECTRIC PLANT

thermostatic control in the station, these bearing units operate to shut down the machine affected entirely, and keep it shut down until conditions again become normal, when the machine will start of its own accord. Thermostats are also used in connection with the control of the current-limiting reactors and the stator coils of the generators. (*Electrical World*, vol. 20, no. 22, December 1, 1917, pp. 1042 to 1045, 7 figs.; and *Power*, vol. 46, no. 24, December 11, 1917, pp. 790-793, 7 figs., *d*)

THE FLOW OF WATER IN SIPHONS, Mark Halliday. Analysis of the flow of water in siphons. The writer considers two cases: first, that of a single siphon with one pump, and second, an amended arrangement.

In the case of the simple siphon shown diagrammatically in Fig. 5, he derives the following equation:

$$\frac{h_3}{l_2} = \frac{34 - h_2}{l}$$

where $h_3$ is as indicated in the diagram, $l_2$ is the length of the

pipe from $A$ to $C$, $h_2 = H_2 - H_3$, as indicated in the diagram, and $l$ is the length of the pipe in feet.

Unless this relationship holds, the siphon will not work continuously without a regulating valve. It will be noted that $h_2$ equally as much as $h_3$ governs the discharge. If $h_3$ is excessive, then $v_3$ tends to become larger than $v_2$, and cavitation in the pipes will result.

This explains the statement made so frequently that some siphons work better when the valve at the delivery end is partly closed. This must necessarily be the case, as the valve must be regulated until ($v_3 \times$ area at $C$) = ($v_2 \times$ area at $B$).

The same reasoning when applied to the Nicholson compound siphon results in the following deductions.

Fig. 6 shows the diagrammatic arrangement of the siphon; $H_3, \frac{p_3}{62.4}$, and $v_3$ are the static, pressure, and velocity energies per pound of water, respectively, at the air inlet $N$ of the

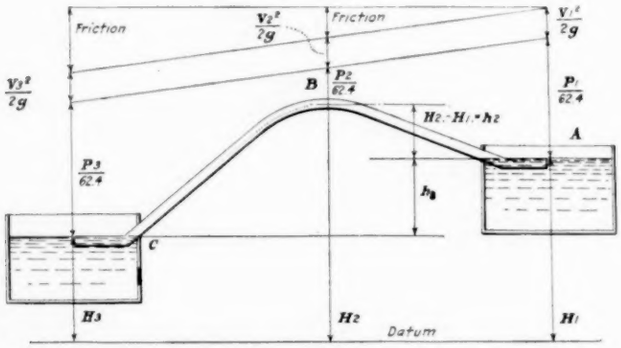



FIG. 5 SIMPLE SIPHON SHOWN DIAGRAMMATICALLY

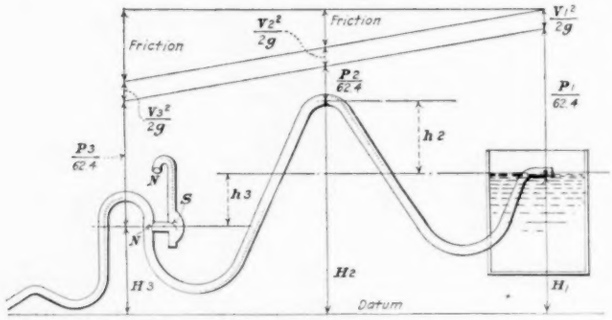



FIG. 6 AMENDED SIPHON

compound siphon. Then if the air inlet and trap $N$, $S$, $N$ is fixed in a position according to the relationship in Equation [14], viz., such that $\frac{h_3}{l_2} = \frac{34 - h_2}{l_1}$, the compound siphon will discharge as much water as any simple siphon.

It has been assumed throughout that $f$, the coefficient of friction, is the same for the whole length of pipe considered; also, in order to simplify the argument, that $p_3 = 0$.

For a maximum discharge this would be so, but the analysis would hold equally well if $p_3$ had a value of a few feet.

In that case the figure could be inserted to slightly modify the result in equation. (*Transactions of the Institution of Mining Engineers*, vol. 54, pt. 2, November 1917, pp. 107-112, 2 figs., *t*)

## Internal-Combustion Engineering

LIGHT DIESEL ENGINE FOR MOTOR VEHICLES, Cole Newman. The writer claims that the modified-cycle Diesel engine with compound expansion would make this type applicable to motor vehicles, and further suggests the use of steam from jackets to modify cylinder pressures.

Germany is said to have just produced a Diesel aeroplane engine of the Junkers type weighing 3½ lb. per hp. It consists of double pistons in each cylinder working in opposite directions, giving a well-balanced engine practically free from vibration.

In this country it has been demonstrated that fuels heavier than kerosene cannot be successfully carburetted.

The problem is therefore how to handle the fuels. Automobile engineers hesitate to complicate the automobile engine with delicate injection apparatus, and, in fact, the amount that would be injected each time into the cylinder of an automobile engine of the Diesel type would be so small that it appears questionable whether it could be accomplished or not.

It would seem more practicable to atomize these heavy fuels and mix them with the ingoing air, after which they could be exploded by the heat of compression. An ordinary spark plug will not ignite such a mixture, or even if it were ignited a great deal of smoke and carbon deposit would result. But the compression of the charge to high pressure completely evaporates the finely atomized mist of fuel, and finally ignites it. Certain auxiliary features would be necessary for such an engine, viz., control of the point of ignition so as to prevent preignition, which might be accomplished either by varying the compression or by admitting variable amounts of water with the fuel.

The writer suggests the use of a compounded internal-combustion engine; for example, the following arrangement: a six-cylinder internal-combustion engine having four high-pressure cylinders of the four-stroke-cycle type and two low-pressure cylinders receiving exhaust from one or the other cylinder at every stroke. Assume that the four cylinders operate on the Diesel cycle by means of an atomized mixture of air with heavy fuel ignited by compression and controlled by water admission. Assume, in the first place, that the high-pressure cylinders only are water-cooled and the low-pressure cylinders properly lagged, as in the case of any steam engine. Assume that the heat of the water is utilized by permitting it to boil in the jackets. The steam from this water is admitted to the carburetor. Such as is not needed can be bypassed into the radiator. Therefore, the greater part of the heat lost to the jackets is restored to the cylinder at a lower temperature but greater heat mass. It enters the cylinder with the mixture of fuel and air, and controls the ignition point as desired. The mixture of the products of combustion with the greatly superheated steam after explosion passes through the exhaust valve to the low-pressure cylinder. The low-pressure cylinder, therefore, has not only that portion of the pressure derived from the high-pressure cylinder, but also the heat of the steam from the water jacket and of the exhaust, which is usually wasted, to turn into useful work. The cylinder also acts as a muffler, eliminating that apparatus entirely. Although a six-cylinder engine, it would give eight impulses per revolution of the crankshaft. (*Automotive Industries*, vol. 37, no. 26, December 27, 1917, pp. 1134-1135, *t*)

UNIFORMITY OF INTERNAL-COMBUSTION MOTORS WITH 6 AND 8 CYLINDERS, E. Pistolesi. (*Accad. Sci. Torino*, 52. 1, pp. 162-186, 1916-1917.) This question is of particular interest in connection with submarine motors where the use of a fly-

wheel is inconvenient. The author investigates the applicability of Wittenbauer's method to the case of multicylindered engines, and from the results obtained in specific cases he draws the following conclusions for engines of the same class as those investigated: (1) Four-stroke, six-cylinder motors with two compressors need a flywheel of moderate dimensions. The arrangement of the compressors has but small influence on the regulation. (2) Two-stroke, six-cylinder motors with their rods at an angle of 60 deg. need a small flywheel. The compressors have a preponderating influence on the regulation, and their position needs careful investigation. (3) Two-stroke, eight-cylinder motors with two compressors need no flywheel, provided all eight cylinders operate simultaneously. The compressors have a preponderating influence on the regulation, and with a suitable arrangement of these it is possible to attain a high degree of regularity. (*Science Abstracts*, Section B—Electrical Engineering, vol. 20, part 11, no. 239, November 30, 1917, p. 405, *t*)

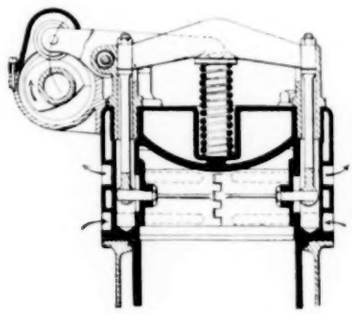


FIG. 7 ONE CYLINDER OF HOWARD CUFF-VALVE ENGINE

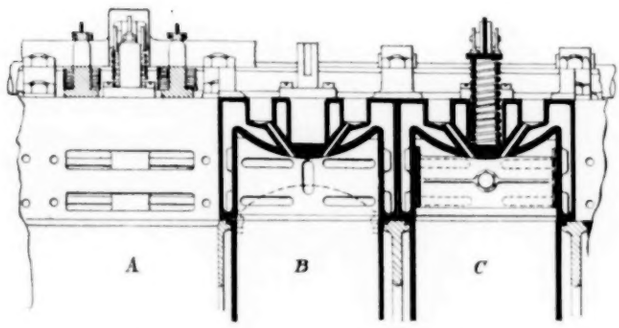



FIG. 8 THREE CYLINDERS OF HOWARD ENGINE

THE HOWARD CUFF-VALVE ENGINE. A type of engine combining to a certain extent the features of sleeve and poppet valves, which valve system is briefly described in the following paragraphs:

In a detachable cylinder head are arranged annular inlet and exhaust ports, both these rows of ports being covered and opened by the reciprocation of a broad but light ring somewhat resembling a wide piston ring. The ring is just wide enough to cover both sets of ports with sufficient overlap to prevent leakage. It is split and tongued at one point of its circumference, so as to make it elastic and to enable the compression and explosion pressures to press it tightly to the wall at the cylinder head. During these pressure periods of the cycle the valve is at rest and practically forms part of the cylinder-head wall, so that it can become only a few degrees hotter than the latter, which is water-cooled.

At the end of the explosion stroke the valve is moved downward, and immediately the exhaust port is uncovered the remaining explosion pressure is released. The valve then ceases to grip by reason of the internal pressure being released and can be moved merely to open and then to close the exhaust ports. When the valve has moved upward sufficiently to close the exhaust ports it continues this movement and immediately uncovers the inlet ports. At the correct moment it descends again and closes the inlets, remaining at rest in its mid-position during the next two strokes, held tightly to the cylinder-head wall over the ports by the internal pressures on the compression and explosion strokes.

The mechanism for operating the valve is shown in Figs. 7 and 9. The first shows the valve at the top and also the special cam and operating levers. Only one helical spring is shown, but in practice two concentric springs are used, wound in opposite directions to prevent periodicity.

In Fig. 8 is shown an outside elevation of one of the cylinders at *A*, indicating the height of the valve gear above the piston. *B* is a vertical axial section with the valve and its actuation removed to show the arrangement of the ports. The highest point reached by the piston is shown in broken lines, the top ring indicated being of the obturator type. *C* is a complete vertical section.

Fig. 9 shows the actuation of the cuff valve. This view

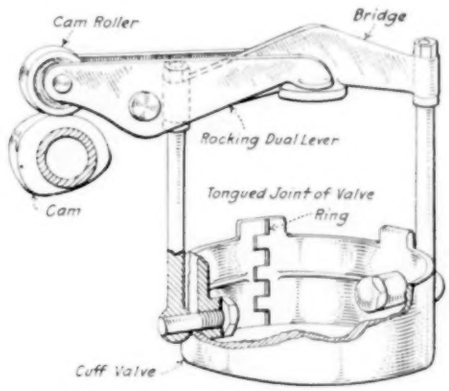



FIG. 9 HOWARD CUFF VALVE AND ITS ACTUATION

shows the trunnion-pin bosses and the manner in which the ring is split and tongued at one point in its circumference to allow expansion and to ensure gastightness.

It is stated that in a six-cylinder engine 105 mm. by 106 mm. bore and stroke and developing about 140 hp., the weight of each valve and its actuating mechanism is about 15 ounces. (*The Autocar*, vol. 39, no. 1154, December 1, 1917, pp. 540-543, 5 figs., *d*)

THE EFFICIENCY OF THE MOTOR, George Crouch. *Motor Boat*, vol. 14, no. 24, December 25, 1917, pp. 13-16. Brief consideration of the efficiency of the motor-boat engine, which the writer considers to be low in ordinary motor boats.

## Lubrication

MICHELL'S AUTOMATIC LUBRICATING GEAR. Description of a new type of apparatus, the purpose of which is to lubricate bearings during starting and stopping by means of an automatic device which does not require the application of any auxiliary driving power. It was developed by Mr. Michell, the inventor of the Michell thrust and journal bearings. This

apparatus, which is really a specialized accumulator, requires no pumps for its operation, but is actuated entirely by the flow of oil which is maintained under pressure between the working surfaces of the bearing during running at normal speed.

As shown in Fig. 10, the top brass of the bearing is pivoted on a hollow stud making oil-tight contact with the brass through which a hole is drilled to its working surface at or near the point where the oil pressure is a maximum.

Assuming that the bearing is subject to a constant load of 500 lb. per sq. in. of the projected area of its brasses, oil is supplied during the normal running of the machine by the automatic action of the pivoted brass through the pipe and valves provided in the apparatus at a pressure of, say, 900 lb. per sq. in. The outer end of the hollow stud is connected by the pressure pipe to the accumulator cylinder constructed on the intensifier principle. As shown to the right in *B* and *C*,

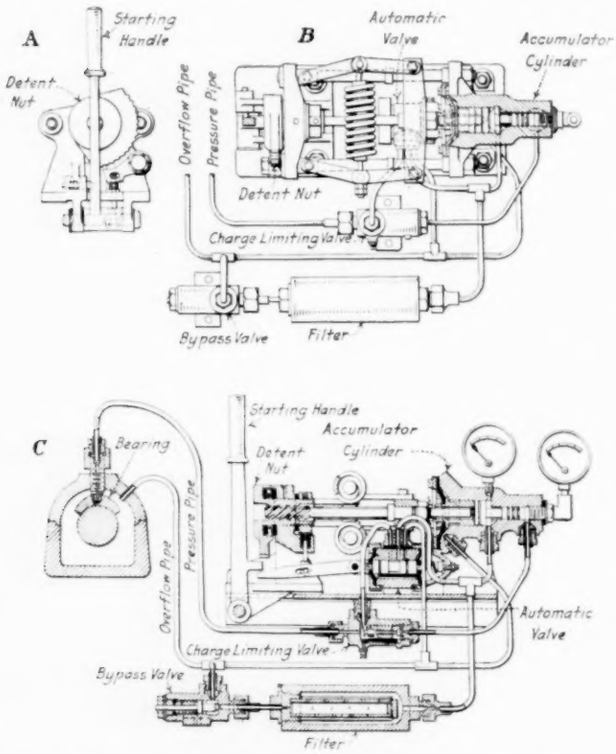



FIG. 10 MICHELL'S AUTOMATIC LUBRICATING GEAR

Fig. 10, it has a large and a small chamber in tandem, and is fitted with a stepped plunger turned to corresponding diameters. The pressure pipe delivers oil from the bearing into both chambers of the accumulator, forcing the plunger outwards and extending the loading springs, which are arranged to apply a practically constant load on the plunger of the accumulator by means of the toggle motion shown in *B*, Fig. 10.

When the outward motion of the plunger is completed it is held in that position by means of a detent nut and a pawl engaging with the nut, *A*, Fig. 10, whether the bearing continues to run or not, until the starting handle is shifted to the starting position. The accumulator is fully charged in a few minutes of normal running and the plunger remains at the outer end of its stroke during the remainder of the time that the motor is running and after it stops.

As the detent nut retains the plunger against the load imposed by the loading springs, *A*, Fig. 10, the latter imposes no pressure on the oil once the pawl is engaged, and little or no leakage takes place from the accumulator while the motor is stopped.

At starting the whole tension of the loading springs is applied to intensify the oil pressure in the small chamber of the accumulator up to, say, 2500 lb. per sq. in., oil at this pressure being discharged back through the pressure pipe to the bearing. By this means a film of oil is forced between the bearing surfaces lifting the rotor to the extent of, say, 1-1000 of an inch, and allowing it to start without solid friction on the bearing surfaces, with a comparatively very small starting current. Actual tests have shown that, whereas the coefficient of friction of the bearings on their brasses amounts to 0.18 under the usual conditions of starting, even if the starting is effected almost immediately after stopping so that the surfaces retain an appreciable amount of oil, the effective coefficient drops to less than 0.01 when the accumulator is used for starting.

In practice, one accumulator may supply all the bearings of the unit on which it is installed, and even can be made to serve several units. (*Engineering*, vol. 104, no. 2708, November 23, 1917, pp. 548-549, 7 figs., *d*)

CHARACTERISTICS OF SYSTEMS OF LUBRICATION FOR MOTORSHIPS, Thomas E. Coleman. *Motorship*, vol. 3, no. 1, January 1918, pp. 19-20, 2 figs., 2 charts. An abstract will be given in an early issue.

SIMPLE PROBLEMS IN FORCED LUBRICATION, Lord Rayleigh. *Engineering*, vol. 104, no. 2711, December 14, 1917, p. 617, 2 figs.

## Machine Shop

HEAT TREATMENT AND TEMPERATURE MEASURING FOR SHELLS, J. R. VanWyck. Description of a method of heat treatment and temperature measuring that was used in the manufacture of two million 3-in. Russian shrapnel shells.

Lead-bath furnaces with room for eight shells and a preheater with room for 20 shells were used, all shells being heated and cooled in exactly the same manner. The shells in the preheater were heated from 700 to 900 deg. fahr. before being placed in the lead, pure lead being used for the bath and thermocouples being employed to take the temperature of the bath.

The article describes in detail the method of heating the bath, regulating the temperature of the lead and the signal system of colored lights employed for regulating the furnace. Base-metal thermocouples were used, these thermocouples being made right in the shop.

A very careful and systematic method of checking the working base thermocouples with the standard base-metal couples in the electric furnace was used once a week. The standard base-metal thermocouples were calibrated with the aluminum-rhodium thermocouples by removing the protecting tubes and tying together, but not touching, with asbestos tape. (*American Machinist*, vol. 47, no. 25, December 20, 1917, pp. 1087-1090, 10 figs., *d*)

MANUFACTURING OPERATIONS IN MAKING A GASOLINE MOTOR. *American Machinist*, vol. 48, no. 1, January 3, 1918, pp. 1-4, 15 figs. In this article are shown jigs and fixtures for machining the parts of a gasoline motor. The operations for machining the cylinder are taken in sequence and speeds, feeds and operating time are given. An interesting jig for drilling

the intake manifold, which is provided with a toggle equalizing mechanism for centering and holding the part, is worth noting.

BORING AND REAMING TOOLS FOR 220- AND 270-MM. FRENCH SHELLS, James Forrest. *American Machinist*, vol. 48, no. 2, January 10, 1918, pp. 70-72, 5 figs. The French type of shell is difficult to machine internally on account of its closed flat bottom and the overhang of the boring bar required. The contour of these shells is shown, and it will be seen that the inside surface is a combination of straight bore, taper bore, radius, and flat surface. How this surface is machined, with a description of the tools involved, is set forth in the article. As the operations and tools are the same for both shells, with allowances for different dimensions, the article treats of the 270-mm. shell but applies equally to both.

USE OF DIAMOND TOOLS IN THE SHOP, Frank A. Stanley. *American Machinist*, vol. 48, no. 2, January 10, 1918, pp. 49-51, 18 figs. A description of a variety of purposes to which diamonds may be put, such as turning, boring and reaming appliances for brass, iron and steel, hard rubber and compositions. Details of speeds, feeds and output are given.

OPERATING CHARACTERISTIC OF MOTOR-DRIVEN PLANERS, C. E. Clewell. *Electrical World*, vol. 71, no. 2, January 12, 1918, pp. 87-90, 5 figs. Contains an analysis of the duty cycle of the planer and a discussion of the requirements of the driving equipment. The non-reversing motor is described and compared with the reversing equipment. Special emphasis is placed upon the method of control which is required. Incidental items, like the reduced flywheel effect due to the absence of pulleys with the reversing motor, the advantages of dynamic braking, remote control and the automatic action of the master switch in connection with the controller are also treated at some length. Economic advantages are set forth which may result directly from a careful study of cutting speeds of the return strokes, increasing the ratio of the latter to the former, eliminating the time losses from belt slip at the points of reversal, and the like.

METAL FRAMES AND FITTINGS FOR AIRPLANES, Fred H. Colvin, Am.Soc.M.E. The writer describes the production of parts, which, in the earlier stages of aircraft engineering, used to be made of wood, but are now being made of metal. This applies in particular to tail-skid and rudder parts and details of control apparatus, especially the vertical stabilizer. The article is interesting, but not suitable for more detailed abstracting. (*American Machinist*, vol. 47, no. 25, December 20, 1917, pp. 1075-1077, 9 figs., *d*)

SPUR GEARING PRODUCED BY THE ROTARY-CUTTER PROCESS, Henry E. Eberhardt. A historical article showing the development of this method of spur-gear manufacture and telling of the writer's connection with it.

The writer strongly defends the use of gears cut with disk cutters, but points out that other methods have also their legitimate field of application. (Paper read before the American Gear Manufacturers' Association at Chicago, September 1917, abstracted through *Machinery*, vol. 24, no. 5, January 1918, pp. 404-405, *h*)

PICKLING WITH NITRE CAKE. *The Iron Trade Review*, vol. 62, no. 2, January 10, 1918, p. 153.

TOOL STEEL GEARS FOR INDUSTRIAL SERVICE, E. S. Sawtelle. *The American Drop Forger*, vol. 3, no. 12, December 1917, pp. 397-400.

ERRORS IN MEASURING THREAD PITCH DIAMETERS WITH WIRES, J. Harland Billings. *American Machinist*, vol. 47, no. 25, December 20, 1917, pp. 1077-1078.

MODERN DRILLING PRACTICE, Edward K. Hammond. *Machinery*, vol. 24, no. 5, January 1918, pp. 381-393, 21 figs.

THREAD MILLING, Franklin D. Jones. *Machinery*, vol. 24, no. 5, January 1918, pp. 413-428, 35 figs.

## Measuring Apparatus

CALIBRATION OF ANEMOMETERS, A. H. Anderson, Mem.Am. Soc.M.E. The writer claims that the method of calibrating anemometers by swinging in a short radius is quite erroneous, and describes another method believed to be more reliable.

Fig. 11 shows the anemometer mounted at the end of an arm 23½ ft. long. One end of the arm is centered on the post of a heavy iron tripod; the other end is supported by a rubber-tired wheel 10 in. in diameter. The trigger is operated by two cords, *A* and *B*, which are loosely supported by two rings near the center of rotation. The operator stands near the tripod, and by means of the cords the counting mechanism of the anemometer is engaged or disengaged while the arm is in rotation.

Such a test as this may be conducted in a large room with

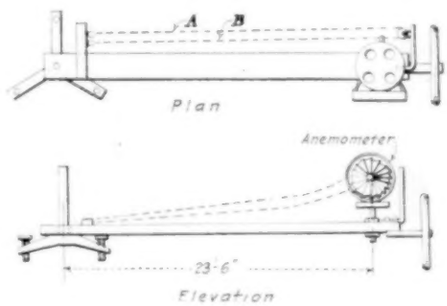



FIG. 11 METHOD OF CALIBRATING ANEMOMETERS

a very smooth floor, and it is also necessary that the air in the room be undisturbed by drafts.

The arm may be rotated at practically any desired speed. At speeds greater than 1000 ft. per min., the rotation of the long arm becomes too rapid for convenient manipulation. The anemometer is then dismounted from the arm and the calibration continued by means of the pitot tube, a blast of air being provided from a centrifugal fan through a round pipe 24 in. in diameter.

This blast of air can be varied by changing the speed of the fan, and beginning with an air velocity of 1000 ft. per min. the reading of the anemometer is noted for the period of a minute and the indication of the differential gage is read. Similar runs are made at suitable intervals up to 4000 ft. per min.

In the original article the data obtained in the test are given in the form of tables; in addition two curves are given showing the relation betwen the true velocities and the velocities indicated by the anemometer. In Fig. 12 the points in the test made with the long arm are indicated by small circles, those obtained by pitot tubes by small triangles, and those obtained by the short arm by small squares. It appears that the short arm might give indications which are lower than with the long arm for equal peripheral velocities. (*The Heating and Ventilating Magazine*, vol. 14, no. 12, December 1917, pp. 15-17, 5 figs., *ep*)

AN INSTRUMENT FOR ACCURATE AND RAPID DENSITY MEASUREMENTS ON BOARD SHIP, A. L. Thuras. *Journal of the Washington Academy of Sciences*, vol. 7, no. 21, December 19, 1917, pp. 605-612, 2 figs.

A SIMPLE POWER FRICTION TEST, W. F. Schaphorst. *The Gas Age*, vol. 40, no. 12, December 15, 1917, p. 563.

PIN MEASUREMENT OF SPUR GEARS, Reginald Trautschold. Pin measurement of spur gears has been developed for determining the pitch diameter of a gear. This system consists simply in measuring the distance between suitably proportioned pairs of pins that bear on the profile pitch lines of pairs of adjacent teeth. In gears with an even number of teeth the pins are inserted between pairs of diametrically opposite tooth spaces. In gears with an odd number of teeth, in which the tooth is diametrically opposite a tooth space, the second pin

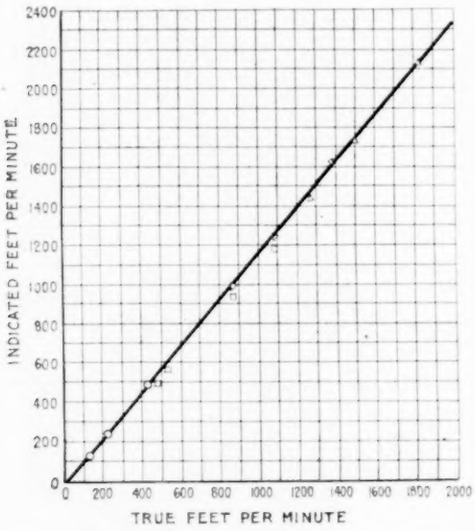



FIG. 12 TRUE VS. INDICATED VELOCITIES BY ANEMOMETER

has to be placed in a tooth space most nearly opposite the first pin.

The writer describes the method of making pin measurements of gears with even and odd numbers of teeth, and also the method of finding the size of pin, and gives the following formulæ used in pin measurements:

$$D = \frac{N}{P} \quad [1] \qquad R = \frac{D}{2} \quad [2] \qquad P_1 = \frac{3.1416}{P} \quad [3]$$

$$\beta = \frac{90}{N} \quad [4] \qquad \beta = \frac{45(P_1 + L)}{1.5708D} \quad [5]$$

$$Y = R \sin \beta \quad [6] \qquad Y_1 = R \sin \beta_1 \quad [7]$$

$$B = R \cos \beta \quad [8] \qquad S = \sqrt{(0.25X^2 - Y^2)} \quad [9]$$

$$S_1 = \sqrt{(0.25X^2 - Y_1^2)} \quad [10] \qquad U = B + S \quad [11]$$

$$O = U \sin 2\beta \quad [12] \qquad H = O \cot 2\beta \quad [13]$$

$W_1 = 2U$ for gears with even number of teeth [14]

$W_1 = \sqrt{[O^2 + (H+U)^2]}$ for gears with odd number of teeth [15]

$$W = W_1 + X \quad [16] \qquad X = 2R \sin \beta \sec a \quad [17]$$

$X > 2Y$ but not $> 2Y \sec a$ [18]

NOTATION FOR FORMULÆ

| | |
|---|---|
| Pitch diameter | $D$ |
| Pitch radius | $R$ |
| Number of teeth | $N$ |
| Diametral pitch | $P$ |
| Circular pitch | $P_1$ |
| Pressure angle | $a$ |
| Half angle subtended by tooth space | $\beta$ |
| Half chordal width of tooth space | $Y$ |
| Chordal ordinate | $B$ |
| Pin center amplitude | $S$ |
| Offset of pin center (for gears with an odd number of teeth) | $O$ |
| Pin center gear ordinate (for gears with an odd number of teeth) | $H$ |
| Diameter of pin | $X$ |
| Pin center spacing | $W_1$ |
| Pin center radius | $U$ |
| Width over pins | $W$ |
| Backlash | $L$ |
| Half angle subtended by tooth space plus backlash | $\beta_1$ |
| Half chordal width of tooth space with backlash | $Y_1$ |
| Pin center amplitude with backlash | $S_1$ |

Strictly, a different size of pin ought to be used for measuring each gear that differs in the number of teeth or in pitch. It is obvious how inconvenient this would be. However, as the writer shows, the same size of pin may be employed for measuring a number of gears of the same pitch but differing considerably in the number of teeth. Within the range of the smallest and the largest gears of the same pitch cut in any particular shop, several diameters of pins may be required, but in all cases the diameter of the pin must fall within certain limits: namely, it must be greater than the standard diameter for the particular gear. Further, for any pin of suitable diameter the amplitude of the pin center, or the distance it lies above the chordal plane of the tooth space, is equal to the square root of the square of half the pin diameter minus the square of half the chordal width of the tooth space.

It is usually estimated that the widths of the teeth and the tooth spaces are equal, but in frequent cases a certain backlash is equivalent to increasing the arc of the pitch circle confined within the tooth space, which makes the pin sink farther down between the teeth. Nevertheless the contact points between the pin and the respective tooth profiles remain on the pitch circle, for the diameter of the pin must remain greater than the increased chordal width of the tooth space.

The original article contains a table giving the pin diameters of gears of 1 diametral pitch, having from 12 to 100 teeth with 14.5- and 20-deg. pressure angles, as well as the diameter of the gears when measured over the pins. (*Machinery*, vol. 24, no. 5, January 1918, pp. 406-409, 5 figs., *tp*)

## Mechanics

RELATION OF PRESS STROKE TO THE LIFE OF A DIE, Wilhelm A. Schmidt, Mem.Am.Soc.M.E. In an article abstracted in THE JOURNAL for November 1917, E. F. Creager discussed the relation of the life of a punch and die with the increase in the length of stroke. The present article further discusses this subject and the writer offers an explanation of the cause of the increase in the life of a die when the press stroke is shortened.

The writer of the present article agrees with the statement of Mr. Creager, namely, that the stroke does not affect the life of the die if the presses are run at the same speed, but defines more fully what is meant by "speed" in this instance. If $\theta$ be the angle between the radius of the crank in a punch press and the line of motion of the arm, then the difference

in the cutting speeds between presses of 1¼-in. stroke and ⅝-in. stroke will become less as this angle approaches zero. Consequently, in cutting very thin metals the velocity in either case will be nearly the same at the instant the metal is struck by the punch, but always slightly in favor of or less in the press having the shorter stroke, as velocities are absolutely equal only when angle $\theta = 0$ deg. or 180 deg., at which times the velocities are also zero. The writer believes that the difficulties in the velocities of stroke readily account for the increased life of the punch and die in the shorter-stroke press running at the same number of revolutions per minute of the crankshaft as that of a press with a longer stroke.

In a case wherein the press is constantly used for stamping metal 0.030 in. thick, is equipped with a roll feed and has a stroke of 1¼ in., the cutting velocity of the punch is 2.966 in. per sec. Assuming that this speed is such as will give a reasonable life to the punch and die, the same protection per life of the punch and die should be obtained in a shorter period of time by using a press with a ⅝-in. stroke and increasing the revolutions per minute of the crankshaft until the cutting velocity of the punch is the same, namely, 2.966 in. per sec. The protection per press will naturally be greater, however, in the second case. (*American Machinist*, vol. 47, no. 26, December 27, 1917, pp. 1131-1132, 2 figs., *tp*)

TORSIONAL RESISTANCE OF ROLLED JOISTS, A. Föppl. (*Zeits. Vereines Deutsch. Ing.*, 61, pp. 694-695, Aug. 18, 1917.) A rod twisted by application of a couple $M$ applied at its ends is deformed (within elastic limit) uniformly and in proportion to $M$. The twist $\delta$ in unit length $= M/JG$; where $G$ = modulus of shear = 850,000 kg.cm.$^2$ for rolled iron, and $J$ is a factor varying with the form of the section, and of the same dimensions (cm.$^4$) as the amount of inertia of the section. Both analytical and experimental methods are needed to solve the problem of determining the torsional resistance of sections used in practice. The author evolves a formula which he considers will be verified by experimental investigation. Almost all the formulæ hitherto available concerning the torsion of rods are based ultimately on St. Venant's researches. Some of St. Venant's formulæ are empirical formulæ intended to give at least approximate solutions for the torsional resistance of any section. These latter formulæ are less reliable. The older of St. Venant's approximate formulæ for rolled joists is $J = 4J_xJ_y/J_p$; where $J_x$ and $J_y$ are the moments of inertia referred to the two principal axes. This formula needs a correction factor which has only been worked out for the simplest cases. The later and more accurate formula is $J = F^4/40J_p$; where $F$ = sectional area. This formula is reasonably accurate for the old standard pattern of I-beam, but fails complete for modern broad-flanged I-beams.

The author's formula is derived from Bredt's (1896) and Prandtl's (1904) works. Most rolled joists may be considered as built up from narrow rectangles, with curves where one rectangle runs into another, these conditions being, however, of no importance as regards torsional resistance. Such sections approximate closely to the limiting case in which the narrow side of each rectangle is indefinitely small compared with the longer dimension, and in that case the torsional resistance of the whole section equals the sum of resistance of the individual rectangles. For a narrow rectangle, measuring $l$ along its greater and $d$ along its less dimension, $J = d^3l/3$. For a rolled joist section, built up from such rectangles, $J = \frac{1}{3}\Sigma d^3l$. This formula is not strictly true, because it is based on the unrealized assumption of infinitely thin rectangles. It is, however, a good approximation, capable of correction by factors determined by experiment. A simple formula for the maximum shear stress ($S_{max.}$) set up in the section by the couple $M$, is $S_{max.} = 3\,Md_{max.}/d^3l$, where $d_{max.}$ represents the smaller dimension of the thickest rectangle in the section. (*Science Abstracts*, Section A—Physics, vol. 20, pt. 11, no. 239, November 30, 1917, p. 507, *t*)

TYPE OF THREAD AS AFFECTING PIPE JOINTS. Data of experiments conducted by the research department of the National Tube Company. The purpose of this investigation was to develop a pipe joint having greater resistance to impact and vibration than the present joints. The investigation was chiefly conducted on 1-in. signal pipe, with some vibratory tests made on 1¼-in. extra heavy pipe and some internal-pressure tests on 2½-in. steam pipe.

Table 1 gives a summary of the tensile-strength, drop and bending tests. Another table in the original article also gives data of vibratory tests. The different joints tested were: First, the regular Briggs thread on pipes and regular Briggs-thread steam coupling; second, round-bottom, sharp-top thread on pipe and regular Briggs-thread steam coupling; third, round-bottom, round-top 55-deg. thread on pipe and regular Briggs-thread coupling; and fourth, round-bottom, round-top 60-deg. thread on pipe and regular Briggs-thread coupling.

The air-pressure and water-pressure tests indicate that equally good joints can be made with mixed threads as with the Briggs thread alone, and, on the whole, the tests indicate that the different types of thread may be used together without any difficulty on the smaller-size pipe and with slight difficulty on the larger-size pipe. But when the thread galls there is some tendency to produce a leaky joint.

TABLE 1—TENSILE TESTS, DROP TEST AND BENDING TESTS ON THREADED PIPE

COMPARISONS OF UNANNEALED STEEL AND ANNEALED STEEL WITH ROUND AND SHARP THREADS AND WROUGHT IRON WITH SHARP THREADS. EACH SERIES OF STEEL PIPE TESTS WERE CUT FROM THE SAME 1-IN. STANDARD-WEIGHT PIPE

| Series No. | Material | Kind of Thread | No. of Tests | Average tensile strength of joints, lb. | Drop test with 26-lb. weight Average number of blows at height of | | Results: pieces broken in drop tests | Bending Tests | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2 ft. 6 in. | 4 ft. | | Angle of bend, deg., average | Pieces broken |
| 1 | Black steel pipe as finished, with Briggs thread | Briggs | 6 | 19,250 | 6.17 | 0.33 | 6 | 39.7 | 6 |
| 2 | Black steel pipe annealed, with Briggs thread | Briggs | 6 | 18,850 | 6.17 | 0.67 | 6 | 80.0 | 5 |
| 3 | Black steel pipe as finished, with round thread | Round | 6 | 21,325 | 7.5 | 6.7 | 1 | 103.5 | 0 |
| 4 | Black steel pipe annealed, with round thread | Round | 6 | 21,850 | 7.5 | 5 | 2 | 109.5 | 0 |
| 5 | Black wrought iron as finished, with Briggs thread | Briggs | 6 | 15,730 | 3.8 | 0 | 6 | 19.0 | 6 |

The following conclusions are drawn from the tests: (1) The round thread is superior to the Briggs thread in tensile strength of joint, in impact resistance, in the amount that threaded pipe may be bent, and in resistance of the joint to vibration. (2) Annealed joints are more resistant to shock, bending and vibration than the unannealed, and equally strong in tensile strength. (3) Steel joints are superior in every way to wrought-iron. (*The American Drop Forger*, vol. 3, no. 12, December 12, 1917, pp. 408-409, 1 fig., *e*)

KONISKA KUGGHJUL, K. G. Karlson. *Teknisk Tidskrift-Veckoupplagan*, 47 Arg., Häft 47, November 24, 1917, pp. 493-496, 15 figs. Description of a new type of bevel gears produced by the Swedish Ball Bearing Works, makers of the S. K. F. ball bearings. An abstract of the article will be given in an early issue.

THE USE OF SOAP FILMS IN SOLVING TORSION PROBLEMS, A. A. Griffith and G. I. Taylor. *Engineering*, vol. 104, no. 2712, December 21, 1917, pp. 652-655, 2 figs., 5 tables. To be continued.

GENERAL THEORY OF PLANE MOTION ROTATION AND TRANSLATION, Francis W. Roys. *The Journal of the Worcester Polytechnic Institute*, vol. 21, no. 1, November 1917, pp. 24-31, 2 figs.

LONG COLUMNS CARRYING DISTRIBUTED LOADS, Arthur Morley. *Engineering*, vol. 104, no. 2709, November 30, 1917, pp. 565-567, 2 figs. Abstract of a paper on the mathematical investigation of the mechanical problems of transmission lines by Koga Kato in the *Journal of the Society of Mechanical Engineers of Tokyo, Japan*. Deals with the cases of struts carrying concentrated end loads and also loads distributed along the length and considers various types of end conditions.

THE WHIRLING OF SHAFTS, H. A. Webb. *Engineering*, vol. 104, no. 2706, November 9, 1917, pp. 483-485, figs. 3-7 Serial article.

WORM GEARING, Francis J. Bostock. *Engineering*, vol. 104, no. 2706, November 9, 1917, pp. 503-506, figs. 7-14, (concluded).

## Motor-Car Engineering

STEAM MOTORCYCLE. Description of a steam-driven motorcycle with a multitubular boiler. This boiler is 9 in. in diameter by 12 in. high, having 120 half-inch copper tubes and carrying a working pressure of 500 lb. A seamless steel tube is used for its construction and screwed-in ends electrically welded. The burner is simple type with pilot arranged for kerosene.

The engine is of the single-cylinder, double-acting type, 2-in. bore and 2½-in. stroke, direct-coupled to the back tail-shaft, having a reduction gear of 6.521. The horizontal tank, divided into two parts, contains fuel and water, the fuel being fed under pressure to the burner. The boiler feed is pumped through two water heaters: first through an exhaust-steam heater and then through a coil placed in the firebox. Superheated steam is used with the superheater again in the firebox. The exhaust is condensed as much as possible by a surface condenser, the hot water being returned to the boiler and the uncondensed steam escaping.

So far the machine has not proved satisfactory because of excessive weight, trouble in the burner in a high wind, small water-carrying capacity, and the wastefulness of the single-expansion engine working on steam at the above high pressure.

The writer adds that the rise in steam pressure and a sudden stop did not make one feel at all at ease in the saddle. (*The Motor Cycle*, abstracted through *The Autocar*, vol. 39, no. 1157, December 22, 1917, p. 629, 1 fig., *d*)

BRITISH SIX-TON STEAM TRUCK. Description of a six-ton steam truck built by Atkinson & Co. of Preston, Lancashire, England, of interest especially because, while running on rubber tires, it uses coke as a fuel.

The steam generator is of the vertical water-tube type with tubes slightly inclined from the horizontal plane. The working pressure is 230 lb. per sq. in. In the combustion chamber is a double continuous coil of tubing forming a superheater through which the steam passes on its way to the engine. The generator is fired from the bottom by means of a chute. The driver merely removes the lid off the chute by his foot and allows a certain amount of coke to drop from the adjacent bunker into the firebox. It is claimed that with this arrangement the level of the fuel is within strict limits, leaving ample combustion space and giving a high thermal efficiency.

The special feature of the engine is the valves, shown in Fig. 13. These valves are large steel balls, of which there are four operated direct from camshafts by tappets. There are two camshafts; the steam inlets are placed above and the exhaust ports below. The exhaust camshaft is driven from the engine crankshaft by a shaft and beveled gearing, and from this through the beveled gearing and a vertical shaft the inlet

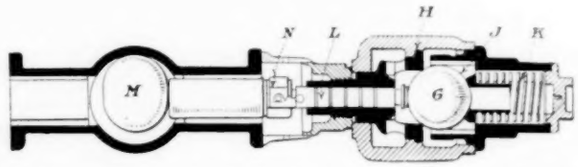



FIG. 13 VALVE MECHANISM OF ATKINSON STEAM TRUCK ENGINE

camshaft is operated. All this mechanism is located in a casing and runs in oil, while a small oil pump on the exhaust-valve camshaft forces oil to all the cams through tubing.

The driving axle is of the solid type, one road wheel being rigidly mounted on the shaft and the other on a sleeve which surrounds the shaft and is carefully lubricated.

The vehicle is equipped with a steam brake which operates on a large drum bolted to the main driving sprocket on the rear axle. When steam is admitted to the rear end of the brake cylinder the piston and rod are forced inwards and the brake band is tightened round the drum by a lever. The brake is released by exhausting the steam from the cylinder. (*The Engineer*, vol. 124, no. 3232, December 7, 1917, pp. 494-496, 11 figs., *d*)

THE TESTING DEPARTMENT OF THE FIAT COMPANY. *The Engineer*, vol. 124, no. 3232, December 7, 1917, p. 504.

THE AUTOMATIC AXLE JACK. *The Autocar*, vol. 39, no. 1157, December 22, 1917, pp. 621-622, 3 figs.

## Munitions

HEAT TREATMENT AND TEMPERATURE MEASURING FOR SHELLS, J. R. VanWyck. See Section: Machine Shop.

THE FRENCH 75-MM. CANNON. In the following list it is to be noted that entries marked * refer to publications which are not in the Library of the Engineering Societies and have not been examined.

1898.—New Field Artillery, 1898. (*Jour. U. S. Artillery*, v. 10, p. 267, et seq.) Based on an article in *Revue de Cavalerie*. Gives reasons leading to the adoption of the 75-mm. cannon, together with some data on dimensions, projectile, etc.

1898.—75-Mm. Rapid Fire Field Material, 1898. (*Revue Militaire Suisse* for Feb.)*

1900.—Modern Field Artillery, The Schneider-Canet Systems, 1900. (*Engineering*, vol. 69.) I, pp. 540-542; description of the 75-mm. gun, illustrations, diagrams. II, pp. 573-577; continues description, etc., of 75-mm. gun, giving data on eight different types, 16 figs. III, pp. 609-611, and IV, pp. 643,646; further descriptions of 75-mm. gun types and illustrations of carriages, limber, brakes, etc. V, pp. 671-672; further description of 75-mm. gun types and illustrations.

1900.—New French Field Gun, 1900. (*Artilleri-Tidsskrift*, Jan. and Feb.)*

1900.—Schneider-Canet Quick-Firing Guns and Howitzers for Field Service, 1901. (*Engineering*, vol. 72. I, pp. 72-75; II, pp. 107-110; III, pp. 210-211; IV, pp. 246-249.) Description of the 75-mm. and other guns, together with tests carried out by Schneider & Cie. at the Harfleur long-range proving ground.

1901.—Schneider-Canet Rapid Fire Field Material, 1901. (*Revue Militaire Suisse* for May.)*

1902.—Field and Position Artillery Material from Schneider & Cie., and Experimental Firing with Same at Harfleur, March, 1901, 1902. (*Artilleri-Tidsskrift*, May, June, Sept., Oct.)*

1902.—Curey and Pesseaud, Capts., Artillerie à l'Exposition Universelle de 1900. Paris, 1902-7, 335 pp., 183 figs., 22 plates. Frs. 6.50.*

1902.—Notes on Rapid-Fire Field Artillery, 1902. (*Jour. U. S. Artillery*, vol. 17, pp. 23 et seq.; translated from the French.) Pp. 38-41 give general information on the 75-mm. gun, as far as published.

1902.—Junken, Chas. A., French Field Artillery, 1902. (*Jour. U. S. Artillery*, vol. 18, pp. 21-32; transl. from *Militär Wochenblatt*, Jan. 1 and 8, 1902.) Description of the 75-mm. gun substituting the 90-mm. gun, including general type and construction as far as known, limber, service, battery, methods of fire.

1902.—French 75-Mm. Gun, Illustrated, 1902. (*Revue Militaire Suisse* for Jan.)*

1902.—Mitteilungen über Gegenst. d. Art & Gen.-Wesens, March, 1902.*

1903.—Hero, Capt. A., Jr., French Rapid-Fire Field Artillery, 1903. (*Jour. U. S. Artillery*, vol. 19.) I, pp. 35 et seq.; diagrams and description of the 75-mm. gun (pp. 37-46), including breech mechanism, carriage, recoil brake, tire brake, shields. II, pp. 164-185; description and diagrams of "laying apparatus and instruments used in preparation for and execution of fire," including collimator, level, graduated plates, methods of pointing, preparation for fire, formation of batteries, etc. III, pp. 47-60; methods of firing, execution of fire, rules for firing, battery organization, etc.

1903.—French Field Artillery Material—75-Mm, 1903. (*Revue d'Artillerie* for October.)*

1905.—Adoption of the 75-Mm. R. F. Gun for Horse Batteries, France, 1905. (*Belgique Militaire* for Dec. 24.)*

1906.—Notes on the 75-Mm. Gun and Regulations Therefor, 1906. (*Revue de Cavalerie* for Aug. and Sept.)*

1907.—Modern French Field Guns, 1907. (*Engineering*, vol. 84, pp. 775-778.) Detailed description and diagrams of the Schneider-Canet 75-mm. field guns, pattern "P D," including dimensions, weights, pressures.

1907.—Olivier, Lieut. L., Material de Montagne Demontable de 75 a Tir Rapids, Systeme Schneider-Danglis. (1907-1912), 40 pp., 15 figs., Frs. 1.25.*

1907.—Range Table of French 75-Mm. Gun, 1907. (*Artilleristische Monatschrift* for Sept.)*

1907.—Brems- und Vorholvorrichtung des 75-Mm. Feldgeschützes M. 97, 1907. (*Mitteilungen über Gegenstände des Art & Gen.-Wesens*, vol. 38, p. 1046.) A description of the brake, etc., of the 75-mm. gun, based on an article in the *Deutsches Offizierblatt*, etc.

1908.—Wirkung der Schrapnells der 75-Mm. Kanone M 97, 1908. (*Mitteilungen über Gegenst. des Art & Gen.-Wesens*, vol. 39, pp. 168-169.) A quotation from Aubrat's Exercises de Service en Campagne, giving results of trials of the 75-mm. shrapnel for comparative effect.

1911.—Ordnance, 1911. (Article in Encye Brit., 11th ed., vol. 20, pp. 189-235.) Table 9, p. 211, and Table 21, p. 214, give data on 75-mm. guns (France); see also ill. plate 3 and descriptive notes on p. 221.

1911.—75-Mm. Halbautomatische Kanonen in Mittelpivotlafette der firma Schneider & Cie., 1911. (*Mitteilungen über Gegen. des Art & Gen.-Wesens*, vol. 42, pp. 764-768, with plates and figs.) Detailed description and diagrams, characteristics, dimensions, breech, limber, munition, etc.; also addition of shield, p. 340.

1913.—*Revue d'Artillerie*, December 1913.

1913.—Moliere, Capt. H., Notes sur le Canon de 75 et Son Règlement, à l'Usage des Officiers de Toutes Armes. 4th ed., paper, Paris, 1913, Berger-Levrault, 136 pp., 65 illustrations, Frs. 2.*

1914.—Artilleries de Campagne Française et Allemande, Le Canon Français de le Canon Allemand de 77, 1914. (*Génie Civil*, vol. 65, pp. 385-394.) Description, illustration and comparison of the two guns, the French 75 especially complete, and partly based on Commandant Buat's l'Artillerie de Campagne, Son Histoire, Son État Actuel. (Abstract in *Jour. Franklin Inst.*, 1917, vol. 183, pp. 374-375.)

1914.—*Revue d'Artillerie*, July 25, 1914.*

1914.—Règles à Observer pour le Tir du Canon de 75 pardessus les Troupes Amies, 1914. (*Génie Civil*, vol. 65, pp. 334.) From an article by Com. A. P. Jamet in *Revue d'Artillerie*, July 25.

1915.—Dalmau, Antonio Ferrer, El Cañon Krupp y el Schneider de 75-mm., 1915. Barcelona, Feliu y Susanna, 39 pp. Pp. 29-35 describe the French 75-mm., 11 figs.; a chapter on the construction of guns is included on pp. 37-39.

1915.—"Soixante Quinze," 1915. (*The Engineer*, vol. 119, pp. 77-78.) Based on an article in Génie Civil, giving descriptions of breech, block, recoil cylinder (as far as published), wheel brake, elevating gear, ammunition wagon, fuse setter, time and percussion fuse, ballistic data, etc.

1915.—75-Mm. Automobile Battery in France, 1915. (*Kriegstechnische Zeitschrift* for May-June.)*

1915.—Range Table of the French 75-Mm. Gun, 1915. (*Artilleristische Monatschrift* for Oct. 14.)*

1915.—Specifications for High Explosive Shells, 1915. N. Y. Industrial Press, 44 pp., chap. 5, pp. 38-44, gives specifications for the French 75-mm. high-explosive shell.

1915.—French 75-Mm. and 105 Mm. Field Guns, 1915. (*Engineering*, vol. 100, p. 535, and pp. 559-561.) Gives dimensions, ballistic data, and a general description of these two sizes of guns.

THE INSPECTION OF SCREW GAGES FOR MUNITIONS OF WAR, J. H. Bingham Powell. *American Machinist*, vol. 47, no. 25,

December 20, 1917, pp. 1065-1073, 5 figs. See abstract in THE JOURNAL for January 1918, pp. 108-109.

LES MODÈLES ACTUALLES DE TORPILLES AUTOMOBILES. *Le Génie Civil,* tome 71, no. 1843, December 8, 1918, pp. 365-371, 21 figs. Description of modern types of automatic torpedoes.

## Power Plants

METHODS OF DRYING OUT FLOODED POWER PLANT EQUIPMENT, Norman L. Rea. *Power,* vol. 47, no. 2, January 8, 1918, pp. 46-48, 4 figs. Discusses various schemes that may be employed for drying out electrical equipment after a power plant has been flooded, and points out the advantages and disadvantages of the various methods.

## Presses

ELECTRIC BALING PRESSES. *Engineering,* vol. 104, no. 2710, December 7, 1917, pp. 600-602, 9 figs.

HYDRAULIC FORGING PRESSES. *The Iron Age,* vol. 100, no. 25, December 20, 1917, pp. 1480, 1522-1524.

## Pumps

DUTY TRIALS ON TWO 24-MILLION GALLON PUMPING UNITS. *Power House,* vol. 10, no. 11, November 1917, pp. 313-316, 3 figs.

AIR PUMPS AND CONDENSERS. *Engineering,* vol. 104, no. 2712, December 21, 1917, pp. 664-665, 1 fig.

SOME NOTES ON AIR-LIFT PUMPING, A. W. Purchas. *The Journal of the Institution of Mechanical Engineers,* no. 8, December 1917, pp. 613-650, 11 figs., 4 tables. An extensive discussion of air-lift-pump design and operation. An abstract will be given in an early issue of THE JOURNAL.

## Railroad Engineering

THE TANK CAR, E. S. Way. *Railway Review,* vol. 61, no. 26, December 29, 1917, pp. 801-803.

MECHANICAL PROBLEMS IN THE DESIGN OF ELECTRIC LOCOMOTIVES, W. K. McAfee. *The Electric Journal,* vol. 15, no. 1, January 1918, pp. 16-19, 8 figs.

THE TRANSPORTATION OF PERISHABLE COMMODITIES, Dr. M. E. Pennington. *Railway Age,* vol. 64, no. 2, January 11, 1918, pp. 119-124, 10 charts.

NEW FOUR-CYLINDER EXPRESS LOCOMOTIVE. *The Railway Gazette,* vol. 27, no. 25, December 21, 1917, pp. 681-683, 4 figs. Description of a new 4-6-0 express locomotive recently completed at the works of the Great Central Railway, England. The cylinders use highly superheated steam on the single-expansion principle. The number of superheater elements has been increased from the usual 24 units to 28 units. The addition of another row of superheater units makes a considerable difference in the maintenance of steam temperature in long boilers, especially when the engine is working under high-duty conditions.

THE "RUSTON" OIL LOCOMOTIVE. *Engineering,* vol. 104, no. 2709, November 30, 1917, pp. 569-571, 7 figs.

THE DEVELOPMENT OF INCLINED PLANES FOR LOCOMOTIVE AXLEBOXES. *The Railway Gazette,* vol. 27, no. 23, December 7, 1917, pp. 623-624, 6 figs.

NEW YORK CENTRAL 4-8-2 TYPE LOCOMOTIVES. *Railway Age Gazette,* vol. 63, no. 26, December 28, 1917, pp. 1167-1170, 4 figs., 1 chart, 1 table.

SCREW-SPIKE AND TIE-PLATE TEST, W. C. Cushing. *Bulletin of the American Railway Engineering Association,* vol. 19, no. 200, October 1917, pp. 3-255, illustrations and charts.

## Refrigeration

MULTI-STAGE COMPRESSION PLANT OF CENTRAL COLD STORAGE CO. *Power,* vol. 47, no. 3, January 15, 1918, pp. 74-78, 6 figs. This modern two-unit ammonia plant of 500 tons refrigerating capacity employs the new D. I. Davis system of multi-stage compression with cooling of vapor between stages. It is expected to save in power 25 per cent over the standard simple compressor and to develop one ton of refrigeration on less than 25 lb. of steam per hour.

## Steam Engineering

THE DIVERGENCE OF STEAM NOZZLES, Gerald Stoney. As in most of the textbooks on steam turbines the theory of the divergence of steam nozzles is not fully given, the following method of calculation may be of interest.

In textbooks on steam turbines it is shown that in expanding adiabatically from a pressure $p_1$ to a pressure $p_0$ the velocity of the steam is

$$C_0^2 = 2gH_1 \frac{\gamma}{\gamma-1}\left(1 - z^{\frac{\gamma-1}{\gamma}}\right)$$

where

$$z = \frac{p_0}{p_1} \text{ and } H_1 = 144\, p_1 V_1$$

At the throat

$$z_t = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}, \text{ where } z_t = \frac{p_t}{p_1}.$$

so that at the throat

$$C_t^2 = 2gH_1 \frac{\gamma}{\gamma+1} \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

If $A_t$ is the area of the nozzle at the throat, and $A_0$ that of the exit, the equation for continuity gives

$$\frac{A_0}{A_t} = \frac{C_t\ V_0}{C_0\ V_t} \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

where $V_t$ and $V_0$ are the volumes of the steam at the throat and exit of the nozzle, respectively.

As

$$p_0 V_0^{\gamma} = p_t V_t^{\gamma}$$

and as

$$p_t = p_1 z_t = p_1 \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}} \quad \ldots\ldots\ldots\ldots [3]$$

we have

$$\frac{V_0}{V_t} = \left(\frac{p_t}{p_0}\right)^{\frac{1}{\gamma}} = \left(\frac{2}{\gamma+1}\right)^{\frac{1}{\gamma-1}} z^{-\frac{1}{\gamma}} \quad \ldots\ldots\ldots [4]$$

Putting Equations [1], [2] and [4] into [5],

$$\frac{A_0^2}{A_t^2} = \frac{\gamma-1}{\gamma+1}\left(\frac{2}{\gamma+1}\right)^{\frac{2}{\gamma-1}} \frac{1}{z^{\frac{2}{\gamma}}\left(1 - z^{\frac{\gamma+1}{\gamma}}\right)}$$

$$= \frac{\gamma-1}{2}\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma+1}{\gamma-1}} \frac{1}{z^{\frac{2}{\gamma}} - z^{\frac{\gamma+1}{\gamma}}} \quad \ldots\ldots\ldots [5]$$

an equation for the flare of the nozzle.

As $z$ is fractional, a more convenient form for calculation is obtained by writing $X = \frac{1}{z} = \frac{p_1}{p_0}$, $X$ being the expansion by pressure; and then [5] becomes:

$$\frac{A_0^2}{A_t^2} = \frac{\gamma - 1}{2}\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma+1}{\gamma-1}} \frac{X^{\frac{\gamma+1}{\gamma}}}{X^{\frac{\gamma-1}{\gamma}} - 1}$$

As the ratio of the specific heats, or $\gamma$, may be considered as practically constant in these equations for the adiabatic expansion of steam, it will be seen that the flare depends only upon the amount of expansion by pressure in the nozzle; that is, that it is the same for a nozzle expanding from 200 lb. per sq. in. to 20 lb. as from 10 lb. to 1 lb. Since, however, the value of $\gamma$ for saturated steam is less than for superheated steam, the flare is slightly less in the latter case.

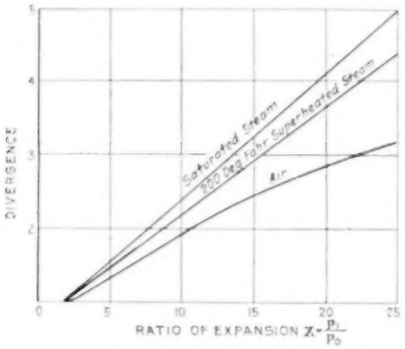



FIG. 14 THEORETICAL DIVERGENCE OF STEAM NOZZLES

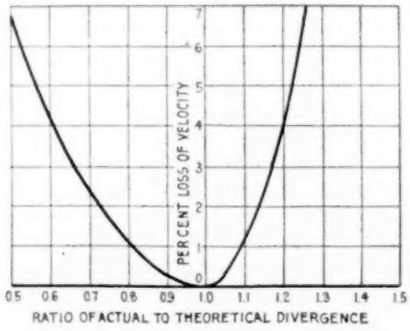



FIG. 15 RATIO OF ACTUAL TO THEORETICAL DIVERGENCE

For the critical expansion $z = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}$, the value of $A_0/A_t$ is unity; and for the ordinary values of $\gamma$, which are from 1.135 for saturated steam to 1.3 for superheated steam, the relation between the flare and the ratio of expansion in the nozzle is approximately a straight line, except for large degrees of expansion.

It may be mentioned that in the common case, where the steam is at first superheated and then becomes wet as it expands, the average value of $\gamma$ is between the value for superheated steam, namely, 1.3, and that for saturated steam, 1.135.

Fig. 14 shows the relation between the flare and the amount of expansion for saturated and superheated steam, and also for air. In this diagram "divergence" is to be understood as the ratio of area at any section of the nozzle to the throat area. In practice nozzles are generally given rather less flare, since it is much more important to have too little flare than too much flare.

That this is so is well shown by the curves given by Mr. W. J. Goudie from an analysis of data published by Dr. Steinmetz. A combination of these curves is given in Fig. 15. Generally friction in a nozzle slightly increases the flare, but in practice that is negligible. Mr. H. M. Martin has pointed out to the author that

$$\frac{\lambda}{\lambda - 1} = \frac{1}{\eta_i}\,\frac{\gamma}{\gamma - 1}$$

where $\lambda$ is, for frictional flow, the apparent value of the index in $pV^\lambda = \text{constant}$, and $\eta_i$ is the efficiency. For many purposes this formula is more conveniently written as

$$1 - \frac{1}{\lambda} = \eta_i\left(1 - \frac{1}{\gamma}\right)$$

As in practice, the efficiency is always above 90 per cent, it is easily seen that the losses in the nozzle have little effect on the flare. (*Engineering*, vol. 104, no. 2710, December 7, 1917, p. 597, *t*)

NEW METHOD OF INCREASING THE EVAPORATION IN BOILERS, Carl Hering. Data of tests on the boiling of water made mainly in open metal cups over a gas flame.

The writer claims to have discovered a new thermal principle in the boiling of water.

He states that when a flame impinges upon the outside surface of any water-boiling vessel which is constantly maintained at a far lower temperature than the flame by the water on the other side of the metal wall, a thin film of gas forms on the flame side of the surface and offers an enormously high resistance to the passage of heat through it. If the temperature of the flame is taken at about 1300 deg. cent. and that of the water is about 100 deg. cent., there is a fall of temperature of about 1200 deg. cent. (2160 deg. fahr.) through this film, which appears to be only about 0.005 in. thick. This means an extremely high thermal resistance.

Present researches indicate that first there is a point at which it is no longer of advantage to further increase this artificial resistance, and next that this point seems to be reached when the temperature of the surface is about midway between that of the flame and that of the water; hence, for water boiling this would be about 725 deg. cent., which means a dull-red heat.

A practical way to introduce this artificial resistance is by means of lugs on the flame side of the surface, which have such a length and diameter that the heat flow through them will maintain their hot ends at about a dull-red heat.

The same thermal resistance may be produced by a long, thick lug or by a shorter but thinner one, provided the ratio of the length to the cross-section is the same, but the quantity of heat flowing through each lug will, of course, diminish with its cross-section.

Several factors are also involved in the determination of the best spacing of the lugs. Theoretically, the best condition would appear to be a very thick bottom, or very thick-walled boiler tubes, that is, one lug of the diameter of the bottom surface of the vessel; but it will be found that this thickness would have to be several feet, making this form of resistance entirely impracticable. The other extreme would be to have innumerable very thin, short lugs close together, which is also impracticable for obvious reasons.

Coming down to practical constructions, it was found that by spacing the same-sized lugs further apart, the greater freedom of the circulation of the hot gases between them increased the flow of heat through each lug, but as there were then fewer lugs per square inch of surface, the total heat flow into the vessel, as a whole, was reduced.

It was further found that the lateral surfaces of the lugs are of particular importance. The lugs may be made slightly conical, so that their bases cover practically the whole surface, while the thinner ends are more apart, to permit the further circulation of the hot gases.

Two interesting series of tests were made with lugs of various dimensions. The data of the tests are shown in Fig. 16. The results of the first series of tests are shown in *A*. In this series the lugs were of the same diameter but of different lengths, the relative flow of heat through a lug being approximately indicated by the heavy vertical lines above them. It is significant that the flow of heat through lug 3 was greater than through lug 4, although 4 is very much longer than 3.

The next series of tests with lugs of the same length but of different diameters is diagrammatically represented in the same manner in *B*. There again we see that there are certain ranges of dimensions of lug diameter which give the best results. Thus, 5 and 6 have approximately the same rate of flow, but the rates of flow between 4 and 5 are obviously different.

In the cup without lugs the heat flow corresponded to the evaporation of about 17 lb. per sq. ft. per hour. But the rate of flow through the lugs themselves was found to be as high

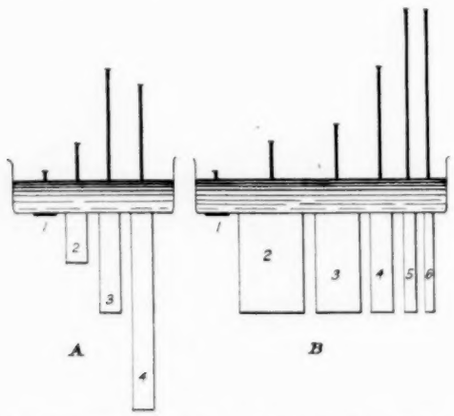



FIG. 16 COMPARISON OF HEAT TRANSMISSION THROUGH PLATES WITH AND WITHOUT LUGS

as 467 lb. per sq. ft. per hour, or about 27 times as high as in the cup without lugs. The spheroidal state which limits this rate was not yet reached.

The present investigation opens up important possibilities, but, as the writer states, requires further research for the determination of various factors which affect the efficiency of the lugs. (*Power*, vol. 47, no. 1, January 1, 1918, pp. 10-13, 3 figs., *eA*)

DETERMINING BOILER EFFICIENCY BY $CO_2$ ANALYSES AND FLUE TEMPERATURES, Haylett O'Neill. *Power*, vol. 47, no. 2, January 8, 1918, pp. 52-55, 12 figs., 2 tables. Gives several charts with the aid of which the boiler efficiency may be closely approximated when the $CO_2$ and flue temperatures are known. The purpose of the article is to enable the engineer to obtain valuable operating data for practical use by means of simple and cheap instruments.

THE LOGAN, WEST VIRGINIA, POWER PLANT. *Power*, vol. 46, no. 25, December 18, 1917, pp. 818-822, 8 figs. This power station, with a capacity of 2000 boiler hp., has with an addition of boiler equipment supplanted 14,000 boiler hp. at surrounding coal mines. A total load of 21,000 kw-hr. was carried shortly after the starting up of the plant by one 500-hp. boiler for 24 hours, the day load averaging 1500 kw-hr. This one 500-hp. boiler did the work of 4100 hp. of isolated mine boilers as formerly operated.

CONVERSION OF SINGLE-EXPANSION TO COMPOUND ENGINES ON FRENCH RAILWAYS. *The Engineer*, vol. 124, no. 3233, December 14, 1917, pp. 511-512, 4 figs.

STANDARD PROPELLING ENGINES FOR BRITISH STANDARD SHIPS. *Engineering*, vol. 104, no. 2709, November 30, 1917, p. 569.

## Thermodynamics

HEAT TRANSFER IN TUBES, W. Nusselt. (*Zeits. Vereines Deutsch. Ing.*, 61, pp. 685-689, Aug. 18, 1917.) The author gives the following formula for the mean coefficient of heat transference $a_m$ in a tube of length $L$:

$$(a_m d/\lambda_m) = 0.03622(d/L)^{0.464}(dw\gamma_m c_{pm}/\lambda_m)^{0.786} \quad \ldots\ldots\ldots [1]$$

Here $d$ = tube diameter, $\lambda$ = thermal conductivity of the gas or superheated steam, $w$ = velocity of flow, $\gamma$ = weight of unit volume of gas, $c_{pm}$ = true specific heat of the gas at constant pressure. If $T_w$ and $T_o$ are the absolute temperatures of the tube wall and gas respectively, $\lambda_m = [1/(T_w - T_o)] \int_{T_o}^{T_w} \lambda . dT$, $c_{pm} = [1/(T_w - T_o)] \int_{T_o}^{T_w} c_p dT$, and $\gamma_m = [\gamma_o T_o/(T_w - T_o)] \log_e(T_w/T_o)$. In these formulae, $\gamma_o$ = weight of unit volume of gas at $T_o$. If $T_w$ and $T_o$ be nearly the same, $\lambda_m$, $c_{pm}$, and $\gamma_m$ can then be taken to be the values of $\lambda$, $c_p$ and $\gamma$ at $\frac{1}{2}(T_w + T_o)$. Equation [1] is true only for velocities of flow exceeding Reynolds's critical velocity. Denoting $(dw_m c_{pm}/\lambda_m)$ by $A$, Equation [1] is true for $A > 1000$ if $p = 1$ atmos., and for $A > 7000$ if $p = 16$ atmos. The formula applies to other sections of flow as well as to plain tubes. If $F$ = cross-sectional area of an annular passage and $S$ that part of the circumference through which heat enters or escapes, the value of $d$ to be used in Equation [1] is $4F/S$. If heat flows through the whole of the outer circumference while the inner tube serves merely as a throttle, $d = (d_1^2 - d_2^2)/d_2$. Equation [1] is applicable either to the heating or the cooling of a gas; the heat-transfer coefficient remains the same if the gas and tube temperatures be interchanged. The three fractions composing Equation [1] are dimensionless, i.e., the constants of the formula are the same whatever the system of units employed; only one system must be used in each fraction, but it need not be the same in all three fractions. The formula applies accurately only when the temperature of gas changes little along the tube; variation in $a$ along the tube may then be calculated easily. In the first half of the tube $a$ is about 8.6 per cent greater than in the second half. The temperature of gas at the end of the tube is $T_2 = T_w + (T_1 - T_w)e - d_m F/W$; but if $(T_1 - T_2)$ be considerable, as in boiler tubes, the only way at present is to consider such short sections that the temperature fall in each case is small.

To eliminate the tedium of evaluating Equation [1] for individual cases, the author gives tables and charts which also show how $a$ varies with the factors on which it is dependent. The data and curves presented relate to air and steam, these being the gases of greatest technical importance. The formulæ, tables, and curves are for: (1) Thermal conductivity as a function of temperature. (2) Heat-transfer coefficients for various

tubes and gas temperatures. The coefficient decreases at constant tube temperature with increasing air temperature; also, with increasing tube temperature, at constant air temperature. (3) Influence of air velocity and pressure, tube diameter and length. Finally there is a chart for the graphical determination of $a$ for air in any case within wide limits. Experience shows that $a$ for boiler-flue gases or the exhaust from combustion engines differs only 1 or 2 per cent from the values for air at equal pressure.

The velocity of gas flowing through a tube with which it exchanges heat varies along the tube inversely with the absolute temperature of the gas. The product $wy$ is independent of tube length. A fundamental distinction is that whereas $a$ decreases with rising air temperature when the air velocity and tube temperature are constant, $a$ increases with temperature when the mass of air passing a given section in unit time is constant. Due to two conflicting factors, the heat-transfer coefficient for air which is warmed as it flows through a tube passes through a minimum value. (*Science Abstracts*, Section B—Electrical Engineering, vol. 20, part 11, no. 239, November 30, 1917, pp. 402-403, *t*)

SPECIFIC HEAT OF WATER, W. R. Bousfield. The writer, in a paper before the Royal Society in 1911, gave figures for specific heats of water at temperatures from 0 to 80 deg. cent. Since then, other investigators, in particular Callendar, by using other methods, have secured data somewhat different from those obtained by the writer, who accepts the superior accuracy of the results of Callendar's new method in the range above 55 deg. cent.

In the range from 0 to 55 deg. the new method has not been applied and the difficulties which it was specially designed to meet at higher temperatures hardly exist in the lower range; since in that range the vapor pressure of water is so small that an accurate correction for evaporation may be easily made.

The corrected figures obtained by the writer were found to be closely in line with those of other observers and indicate that the mean specific heat from 13 deg. to 26 deg. is almost exactly equal to that from 26 to 39 deg., which gives the minimum value in the neighborhood of 25 deg.

The writer points out and discusses the salient differences in this lower range of temperature between his investigations and those of Callendar, but he points out that the course of his curve from 0 to 40 deg., with its minimum at about 25 deg. is in general agreement with the curves of Luedin, Rowland, and Bartoli and Stracciati, while the course of the Callendar and Barnes curve, with its minimum at about 38 deg., differs from all.

The results of a paper which will appear in the *Philosophical Transactions* dealing with the specific heat of certain solutions confirm the writer's position of the minimum very substantially. This paper deals with the determination of the mean capacity of a Dewar vessel in which a novel method of regulating the electric current was adopted. There the position of the minimum was such as to confirm the view of the author, a further confirmation of the same having resulted by a consideration of the actual values of the specific heats of potassium-chloride and sodium-chloride solutions. In this last instance it was found that the temperature-specific-heat curves for saturated solutions indicate a nearly straight-line law from 0 to 39 deg. between specific heat and temperature, a fact which can hardly be a mere coincidence.

The writer points out that until the course of the specific-heat curve from zero to 40 deg. can be considered as definitely settled, there must remain a doubt as to the value of the 20-deg. calorie, amounting to one part per thousand. The reasons for adopting as the standard calorie the mean specific heat over the interval which, undoubtedly, included the minimum point and which is easily reproducible, were stated in a former communication by the writer. The interval from 13 deg. to 55 deg. satisfies all the particular conditions and there remains the difference of over 1/10 of one per cent between the writer's value for the interval and that which results from Callendar's latest figures. (*Proceedings of the Royal Society*, Series A, vol. 93, no. A 655, October 9, 1917, pp. 587-591, *et*)

### Varia

ON THE SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS OF FIRST ORDER AT THE SINGULAR POINTS, Toshizo Matsumoto. *Memoirs of the College of Science, Kyoto Imperial University*, vol. 2, no. 5, August 1917, pp. 255-292.

PHYSICS OF THE AIR, W. J. Humphreys. *Journal of The Franklin Institute*, vol. 185, no. 1, January 1918, pp. 83-117, fig. 47, 6 charts. Serial article (chap. 10).

MECHANICAL DIFFERENTIATION, Armin Elmendorf. *Journal of The Franklin Institute*, vol. 185, no. 1, January 1918, pp. 119-130, 9 figs.

DISCOVERIES AND INVENTIONS. *The Engineer*, vol. 124, no. 3233, December 14, 1917, pp. 514-515.

HIGH-TEMPERATURE DRYING, Burt S. Harrison. *Journal of the American Society of Heating and Ventilating Engineers*, vol. 24, no. 2, January 1918, pp. 213-226.

AUTOMATIC CONTROL OF HIGH TEMPERATURES, R. P. Brown. *The Iron Age*, vol. 100, no. 25, December 20, 1917, pp. 1478-1479.

### Charts

CHARTS SHOWING LOSSES IN STEAM BOILER FURNACES, Haylett O'Neill. *Power*, vol. 47, no. 2, January 8, 1918, pp.52-55.

CHARTS SHOWING THE STEAM-CARRYING CAPACITY OF PIPES UNDER CONDITIONS GIVEN—SUPERHEATED STEAM, W. H. Thies. *Power*, vol. 46, no. 25, December 18, 1917, p. 826.

CHARTS SHOWING THE STEAM-CARRYING CAPACITY OF PIPES UNDER CONDITIONS GIVEN—SATURATED STEAM, W. H. Thies. *Power*, vol. 46, no. 25, December 18, 1917, p. 825.

FRICTION LOSS IN BRICK CHIMNEYS. *The Heating and Ventilating Magazine*, vol. 14, no. 12, December 1917, p. 63.

CHARTS FOR COMPUTING DIMENSIONS AND PROPERTIES OF HELICAL SPRINGS, Donald H. Reeves. *Machinery*, vol. 24, no. 5, January 1918, pp. 432-433.

## CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

# LIBRARY NOTES AND BOOK REVIEWS

*ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.*

## Annual Report of Library Board

THE Library Board administering the Libraries of the American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers, maintained as the Joint Library of the United Engineering Society, has just issued its annual report for 1917.

The Board for 1917 consisted of:

| | |
|---|---|
| Edward D. Adams | John W. Lieb |
| Harrison W. Craver | W. M. McFarland |
| J. V. Davis | Harold Pender |
| Alfred D. Flinn | Calvin W. Rice |
| George A. Harwood | Lewis D. Rights |
| Alex. C. Humphreys | Samuel Sheldon |
| A. M. Hunt | W. I. Slichter |
| Charles Warren Hunt | Jesse M. Smith |
| F. L. Hutchinson | E. Gybbon Spilsbury |
| J. H. Janeway | George C. Stone |

Bradley Stoughton

Mr. George C. Stone was added to the Board on November 23, 1917, as representative of the American Institute of Mining Engineers, to take the place of Mr. E. F. Roeber, whose death occurred on October 17, 1917.

The number of visitors to the Library for the year was 11,371, an average of 40 daily. The service given to both visitors and non-visitors was in the form of 551 searches and 59 translations. The photostat installed in 1916 has proved its value unequivocally; the number of orders was 791, calling for 7853 prints.

Accessions to the Library during the year amounted to 2337 pieces, and the collection totaled, on December 31, 1917, 132,778 volumes and pamphlets.

Arrangements were made during the year for the publication of brief descriptive reviews of new books in the publications of the Founder Societies. The leading publishers of technical books in America have furnished review copies for this purpose, thus enabling the Library to present to both engineers and manufacturers a timely and comprehensive list of nearly all important technical books.

The Library has been the recipient of some very valuable gifts, chief among them being the presentation by the American Society of Civil Engineers of the book stacks used in their building. These have been removed to the Engineering Society Building and have been erected on the fourteenth floor, where they provide the additional room which is so badly needed at the present time. Another valuable gift consisted of 505 volumes relating to electricity, presented to the American Institute of Electrical Engineers by Theodore N. Vail.

Cataloguing has progressed along two lines: one dealing with new accessions, the other with material already in the catalogue. As stated in the 1916 report, the catalogue lacks consistency and needs fundamental and thoroughgoing revision. With a view to this, possible methods of revision have been studied carefully and the process to be followed during the coming year has been selected, so that the work can be begun as soon as the stack room is completed.

There have been some changes in the Library Staff, chief among them being the resignation of Mr. William P. Cutter as Librarian. Mr. Cutter rendered faithful, skilled service during a period of six years, during which the Library has increased in size and usefulness and has acquired a leading position among libraries of engineering. As his successor, the United Engineering Society engaged, in accordance with the recommendation of the Board, Harrison W. Craver, Librarian of the Carnegie Library of Pittsburgh.

The components of a good library are an adequate collection of books and periodicals, a good system of cataloguing, convenient and rapid means of bringing books to readers and an efficient, willing staff.

Considering the Library of the United Engineering Society in these respects, it can first be said that the book collection is, within its limits, probably the best in this country, if not in the world. Widening the scope of the Library by including more adequately some branches of engineering, such as chemical engineering, should be considered.

The present catalogue needs reconstruction, as has already been indicated. This will receive the first attention during 1918 and every activity not immediately essential will be subordinated to it, with the hope that substantial progress can be made.

Certain rearrangements of the reading-room furniture are desirable. The staff is satisfactory and is sufficiently large for the present normal work of the Library.

HARRISON W. CRAVER.

## BOOK NOTES

**Everyman's Chemistry.** The Chemist's Point of View and His Recent Work Told for the Layman. By Ellwood Hendrick. Harper & Bros., New York, 1917. Cloth, 5x8 in., 374 pp. $2.

An extremely readable account of recent progress in the science underlying the dye, the high explosive, potash, nitrogen —written for the purpose of enabling the general reader to obtain something like an adequate conception of the principles of its organic and inorganic branches, and of the important relations they bear to modern life and industry and war.

**The Essentials of Descriptive Geometry.** By F. G. Higbee M. E., Professor and Head of Department of Descriptive Geometry and Drawing, The State University of Iowa. John Wiley & Sons, Inc., New York, 1917. Second Edition. Cloth, 6x9 in., 218 pp., 170 illustrations. $1.80.

In preparing his text the author has aimed to include only those portions of descriptive geometry which possess industrial utility. The subject is discussed from the point of view of the draftsman, and of the three hundred odd problems given a large proportion are of an eminently practical nature. In the present edition a chapter on tangent planes and lines has been added.

**Principles of Natural Philosophy.** By F. J. B. Cordeiro. Spon & Chamberlain, New York, 1917. Cloth, 5¼x8 in., 113 pp., 24 figs. $2.50 net.

A compact, closely reasoned study of force, energy and motion, so interwoven, however, with the frequent speculations of the author that he has selected the Newtonian title used as being more appropriate than mechanics, dynamics or physics. The methods of the calculus are used throughout.

## Library Accessions

AMERICAN CONCRETE INSTITUTE. Proceedings 13th annual convention. Vol. XIII. Purchase.

ANALYSIS OF BRITISH WARTIME REPORTS ON HOURS OF WORK AS RELATED TO OUTPUT AND FATIGUE. No. 2, Nov. 1917. National Industrial Conference Board. *Boston, 1917.* Gift of National Industrial Conference Board.

APPROPRIATION ACTS OF PENNSYLVANIA, 1917. *Harrisburg, 1917.* Purchase.

APUNTES SOBRE LAS MEJORAS MATERIALES APLICABLES A LA AMERICA LATINA. By L. R. Pezuela. *Lima, 1869.* Purchase.

ASCERTAINMENT OF MACHINERY VALUES AND LOSSES. By John Hankin. Read before the Insurance Society of New York. *New York, 1916.* Gift of Insurance Society of New York.

LE BÉTON ARMÉ A LA PORTÉE DE TOUS. By Léopold Malphettes. *Paris, 1917.* Purchase.

BIRDS OF THE ANAMHA ISLANDS. (U. S. National Museum, Bull. 98.) *Washington, 1917.* Purchase.

BOARD OF CIVIL ENGINEERS. Proceedings and Report, to consider the subject of the construction of a rail and highway bridge across the Missouri River at St. Louis. *St. Louis, 1867.* Purchase.

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